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ABSTRACT

This study was conducted in order to gain detailed information about teacher education programs related to the English and Australian conversions to the metric system of measurement. Information was gathered by review and analysis of relevant official and unofficial documents, and by intensive interviews of key persons involved in teacher education activities related to metrication. For each country this report presents discussions of the background for metrication, distinctive features of the educational system (e.g., Teachers' Centres in England), Characteristics of teacher training programs and materials, and problems identified. Thirteen implications for United States teacher training related to the metric system are identified. These concern the role and optimal sequencing of teacher training activities within the overall conversion, the need for and use of quality materials, the need to deal with anxiety and resistance to change, and evaluation. (SD)

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FINAL REPORT

METRIC INSERVICE TEACHER TRAINING:

LEARNING FROM THE ENGLISH AND AUSTRALIAN EXPERIENCE

NATIONAL INSTITUTE OF EDUCATION CONTRACT NO. C-74-0117

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Needless to say, any opinions or errors contained in this report are the sole responsibility of the authors.

Albert B. Chalupsky
Project Director

SUMMARY

Elementary and secondary schools are typically among the first organizations in a country to begin preparations for metric conversion. Therefore, the training of teachers for this event should be planned as an initial, high-priority task in an effective national metric conversion program.

The major objectives of the present study were to review critically the metric inservice training programs for elementary and secondary school teachers in England and Australia, and to develop recommendations for the design of such programs in the United States.

Data were collected through a series of structured interviews with key persons in inservice teacher training in both England and Australia, coupled with a review of supporting documentation and teaching materials. In England, interviews with staff of exemplary Teachers' Centres served as the prime information source; while in Australia information was obtained mostly through interviews with representatives of the Education Departments in three of the six states--those having the greatest population density and industrial development.

The significant characteristics of metric teacher training in each country were documented; including program organization and planning, methods and strategies, teaching materials and equipment, and program results. Specific problems impacting on teacher training in England and Australia were identified, and proposed solutions discussed. One of the features common to both England and Australia was the nearly complete absence of anything approaching a formal and comprehensive evaluation of any aspect of metric education, instructional materials, or teacher training in SI.

Based upon a synthesis of the experiences in both countries studied, a set of thirteen recommendations is presented for educators concerned with metric inservice training in the United States.

GENERAL OVERVIEW

In 1973 the American Institutes for Research (AIR), under the sponsorship of the National Institute of Education (NIE), initiated a study of the metrication experiences in five nations and their implications for U. S. educational planning. Among the important findings of this study was the key role that teachers played in metrication and, in turn, the significant and pervasive impact that metrication had upon all teachers--not merely those in the mathematics and science areas (Chalupsky, Crawford and Carr, 1974).

Since elementary and secondary schools are typically among the first organizations in a country to prepare for conversion, the task of training teachers for this event must be planned for on a priority basis as an initial step in an effective national metric conversion program.

The initial AIR study was intended as an overview of the many problems of metric education and did not focus specifically on the issues of teacher training. A need was recognized both by NIE and AIR for a more directed and intensive study of the metric teacher training experiences and problems in countries that had recently converted to metric. The most effective use of the limited resources available dictated that such a study should concentrate on one or two countries. England and Australia were selected because of their high degree of industrialization, the progressive nature of their educational systems, and their common historical bonds in measurement with the United States. The selection of England and Australia provided an excellent opportunity to study one country that had been involved in a conversion program over an extended period of time, and another country whose later start enabled it to profit from the other's early experiences.

The present study focuses specifically on teacher training concerns in England and Australia and their implications for inservice training in the U. S. For a discussion of the background of metrication and a broader perspective of metric education, the reader is referred to our initial report, Going Metric: An Analysis of

Experiences in Five Nations and Their Implications for U. S. Educational Planning (Chalupsky, Crawford and Carr, 1974).

The specific study objectives of this report are presented next, followed by a summary of data collection procedures. British teacher training in metrics is then described. The subsequent section discusses metric teacher training in Australia. The final section of the report presents our major conclusions and implications for U. S. educators, synthesized from our review of teacher training in both countries.

Study Objectives

The overall objective of this study was to analyze the metric inservice training experiences of England and Australia and to explore how these experiences can help in the design of teacher training programs in the United States. The specific objectives are to:

1. Identify representative examples of metric inservice programs for English and Australian elementary and secondary school teachers.
2. Document the significant characteristics of these programs, especially the approach followed and the methods and materials used in achieving their objectives.
3. Explore the types of problems that have been encountered in metric teacher training and the steps that have been taken, or might have been taken, to overcome such problems.
4. Collect and review samples of training materials used for teacher training in England and Australia.
5. Review what can be learned from the English and Australian experiences and develop recommendations for U. S. educators concerned with teacher training in SI.[1]

[1]Throughout this report the term "SI" is used interchangeably with "metric system" to denote the International System of Units, the modernized metric system.

DATA COLLECTION PROCEDURES

General Data Collection Procedures

This section summarizes the general data collection procedures used in the study. The specific procedures employed in England and Australia are described in the two sections which follow.

Analysis of Existing Data

At the start of the present study a great deal of information related to teacher training in SI was available as part of the data files established at the AIR Metric Studies Center. This data base had been initiated several years ago and was expanded considerably during our previous metric study.

One of the early study activities was the review and analysis of those portions of our data base which were relevant to teacher training in Great Britain and Australia. Among the items reviewed were the following:

- Official newsletters and memoranda
- Circulars from the British Metrication Board and the Australian Metric Conversion Board
- Progress reports and metrication timetables in Britain and Australia
- Standards organization publications
- Newspaper clippings and articles in professional journals and popular magazines
- Responses to questionnaires received from Britain and Australia in connection with the previous study
- Personal communications
- Educational materials produced by both governmental and commercial organizations

Activation of Overseas Information Network

During the previous study, AIR had established an active overseas information network. This network included formal and informal contacts with individuals and organizations directly concerned with metrication in Britain and Australia. Procedures had been developed for obtaining copies of documents and periodic newsletters, as well as other published and unpublished materials relevant to metrication.

Of prime assistance particularly in new data collection efforts were the professional staff that AIR employed in England and Australia. Sometime in advance of our previous study we began a search for overseas representatives. We were especially concerned that these representatives, who would ultimately serve as coordinators for more extensive data collection efforts, would be professional behavioral scientists, skilled in the conduct of social science research and capable of devoting a portion of their time to the collection of information or to the supervision of data collection teams. An additional requirement was that any representatives we would employ should be independent of the organizations charged with metric conversion, in order to ensure a reasonable degree of objectivity in our data collection.

We were especially fortunate in both England and Australia to have former AIR staff members (now associated with universities) agree to serve as our representatives. These same representatives agreed also to serve as our data collection coordinators for the present study.

Development of Interview Guide

One of the major activities during the early period of the present study was the preparation of a guide for conducting interviews in England and Australia. The development of the guide proceeded in four stages:

1. A draft outline was prepared based on previous AIR staff experience in instrument design for projects with similar requirements. Experience gained during the earlier NIE study also provided a valuable input to this task.

2. The draft outline of information areas was then reviewed and revised in cooperation with our English staff, who were visiting AIR at the time. Following extensive discussion, the data collection instrument was greatly revised and expanded.

3. The guide was then critically reviewed by a ser [illegible] staff member not involved in the early design efforts. In addition, the instrument was reviewed and discussed with specialists in teacher training in a state Department of Education. The guide was also reviewed by a mathematics consultant in the San Francisco Bay Area intimately associated with the planning and implementation of metric inservice workshops.

4. The results of these several reviews served as the basis for the preparation of the final instrument which was then forwarded to project staff overseas.

These special efforts in the design of the guide were critical for project success for a number of reasons; primarily, because of the fact that the project data collection would be carried out in widely separated locations, in a relatively short period of time, and with little opportunity for close monitoring and re-interviewing due to budget and time constraints.

Data Collection in England

Data collection preparations and interview scheduling were well underway in England even before the final version of the interview guide was received by the AIR staff in that country.

Initial interviews were held with the British Metrication Board's Head of Education and Industrial Training and with the Staff Inspector for Metrication in the Department of Education and Science, the two key British contacts in metric teacher training. Both of these contacts provided invaluable assistance by identifying exemplary inservice metric

training programs and suggesting other sources of information.

Personal interviews were conducted with key personnel (wardens, curriculum specialists, etc.) at 10 Teachers' Centres, covering general mathematics training as well as metrics and also such specialized areas as home economics and handicraft. These Centres were broadly dispersed across England and served communities widely varying in size and character. Contacts were also made with local education authorities, equipment suppliers, education foundations, various county education committees, advisors, school principals and teachers. A list of the agencies supplying information for this study is included in the Acknowledgements section.

During the course of the interviews, a wealth of background material was collected and forwarded to the AIR Metric Studies Center. These included instructional guides, handbooks, lists of resource materials, publications of the British Metrication Board and county education committees, bibliographies, and journal reprints.

Data Collection in Australia

Representatives of educational departments in the three most densely populated states were interviewed and the results integrated with the findings from publications and reports. These three states were Victoria, New South Wales and Tasmania. Personal interviews were augmented with supplementary correspondence. Telephone interviews were also conducted with representatives in more remote locations. In addition, questionnaire data and documents gathered in Queensland during the previous AIR study were analyzed.

Extensive metric instructional and informational material was obtained and forwarded to the AIR Metric Studies Center to be used as reference backup to the interview data. These included copies of official governmental reports, bulletins and announcements which set the metric conversion teacher training processes in motion, along with actual teaching aids used in several states.

ANALYSIS OF ENGLISH EXPERIENCES

Introduction

Background of British Metrication

In 1965, after fifteen years of studies by various committees, the President of the Federation of British Industries informed the Government that a majority of the members of the Federation, both in the number of firms and in the total size of the business, was in favor of the adoption of the metric system as the primary and ultimately the only system of measures to be used in Great Britain.

In May 1965, the President of the Board of Trade gave the Government response in a statement in the House of Commons to the effect that it was deemed "desirable that British Industries on a broadening front should adopt metric units, sector by sector, until that system can become in time the primary system of weights and measures for the country as a whole ... " (Hansard, 1965).

Early in 1966, the Minister of Technology established the Standing Joint Committee on Metrication. After considering a number of specific problems relating to metrication in industry, including the implications of such a change for education, a recommendation was made to create a Metrication Board to facilitate the conversion process.

The Minister of Technology, in response to the committee report, announced the acceptance of that report in a statement to the House of Commons on July 26, 1968, including the establishment of a Metrication Board "as soon as possible" (Hansard, 26 July 1968). The Metrication Board was established and held its first meeting in May 1969.

Eight committees were set up by the Board to assume responsibilities for the most important sectors of British economy, one of which was the Steering Committee for Education and Industrial Training. The National Union of Teachers (N.U.T.) noted with regret that only one representative of education was named to the Metrication Board and that the Committee on Education and Industrial Training had no teacher

representatives (National Union of Teachers, 1971).

A general overall target date of 1975 was set for Britain to achieve conversion; no firm schedule, however, was set by the Board for educational conversion. Schools were exhorted to keep fully informed of developments throughout Great Britain and to keep pace with or exceed the conversion schedules of individual industries.

To orient the U. S. reader and set the stage for the discussion of teacher training in England, a brief review of the English educational system is presented next.

The English Educational System

In England, education is compulsory for children between the ages of five and sixteen. Primary education extends from age five to age eleven (or if there is a nursery class, from age three to eleven). Publicly maintained primary schools are typically divided between separate infant departments (ages five to seven) and junior departments (ages seven to eleven) of the same primary school, or between separate infant and junior schools.

Until the early 1960's, there were three main types of publicly maintained secondary schools, known as "grammar," "modern," and "technical" schools. The entrance to the different types generally depended on the results of tests taken at the age of about eleven. Of the three types, the grammar schools and the secondary modern schools were the most common. Grammar schools were aimed at children selected as suitable for an academic education aimed at university entrance. Secondary modern schools were originally designed to give a general education "with a practical bias," but later many expanded their approach to include academic courses. More recently, the comprehensive schools have been increasing in importance. These are nonselective and provide all types of education for all or most of the children in a district, from the least to the most intellectually able, and typically cover the full secondary age range of eleven to eighteen.

In some districts there has been a recent reorganization leading to the development of a three-tier system, comprised of lower, middle

and upper schools. Lower schools are for children aged up to eight; middle schools are for those nine to twelve; and upper schools for those over twelve. All these schools are comprehensive.

Most of the schools supported out of public funds are maintained by local education authorities (LEA's). These are of two types: county schools and voluntary schools. The county schools are provided and fully maintained by the LEA's. The voluntary schools, most of which were provided initially by religious denominations, receive support from public funds in proportion to the degree of independence from denominational religious instruction. Children in schools totally supported out of public funds receive religious instruction of a nondenominational character.

The managers or Governors of the schools are responsible for the general direction of conduct and the curriculum; and, although examination pressures force a certain amount of uniformity, head teachers are free within wide limits to organize schools according to their own ideas. Teachers are not bound by official instructions on syllabi, textbooks and teaching methods, according to a report by the British Information Services (1971).

Metric Education in Great Britain

Probably the first important metric education meeting was that staged by the Royal Society. The Society called a conference of representatives of many bodies concerned with the effect of metrication on schools. This took place in March 1968. Organizations represented included the Department of Education and Science; the Ministry of Technology; many of the universities; the professional associations of teachers, mathematicians and scientists; a number of Examination Boards; and the publishers' associations.

The conference provided an opportunity for teachers to hear industry timetables. This was necessary because industry had led the conversion to metric throughout Britain. There were discussions among teachers so that an agreed-upon policy could be reached and publicized. And, there were considerations of the materials and textbooks that would be

required immediately. Above all, there was concern about the organization of early preparatory courses for teachers.

It should be remembered, at this time, in 1968, Great Britain was still using pounds, shillings and pence, as well as miles, pints and hundredweights. General use of decimal coinage was three years away. In Britain, changing to the decimal money system immediately prior to conversion to metric presented complications that will not be faced in the U. S.

In the first report submitted to the Government by the Metrication Board (1970), the primary schools were encouraged to start training at once in SI at a level so that primary students would "think in SI units." It was recommended that instruction in imperial measures should be continued on a temporary basis, in the nature of second language training. No clear time directives were given to secondary education, examining boards in education, or adult/vocational education. Those responsible for school curricula had already developed preliminary plans for metrication by the time the Board was functioning.

A crucial discrepancy recognized from the start was that students in the primary schools would be using metric units long before the general public and the world outside the classroom. The early 1968 conference decided to accept that dilemma and recommended that within one year from that date the emphasis in all primary schools should be on metric units. After that, imperial units would be used for practical work but calculations would all be done in metric.

The Education Sector of the Metrication Board established a committee to investigate and recommend standards of accuracy for equipment and measuring aids. Both teachers and equipment manufacturers were on the committee.

Miss Edith Biggs, who at the time of our interview was Staff Inspector for Mathematics of the Department of Education and Science, reported that both teachers and the educational system have kept well ahead of the schedule of the rest of the country. Primary schools, in particular, reacted much faster and were ahead of schedule in the earlier years.

Due to slippage in metrication schedules of many sectors of British economy, educators have felt real concern that such delays might signal a halt to metrication. The National Union of Teachers expressed its concerns and position in Metrication: No Turning Back (1971). This position paper highlighted the following progress in education:

1. Primary schools had committed themselves to metrication and many had completely converted.
2. Most, if not all, secondary schools already deal in metric units, particularly in math and science. With the widespread change to metric units in many industrial areas, increased attention to these units will be necessary--irrespective of what happens to the progress toward metrication generally.
3. Colleges and Departments of Education in universities had committed substantial resources to teacher training in metrics.
4. Considerable effort had been made in inservice training by teacher groups, LEA's and Teachers' Centres.

The N.U.T. policy statement argued that education had progressed substantially--past the point of no return--by July 1971. Schools assumed that metrication would be an accomplished fact by 1975. They felt "they would have been irresponsible in the extreme to have done otherwise, or failed to translate the conclusions into practical action"(1971, p. 6).

In retrospect, it appears that British educators could, and did, make an urgent effort to convert. In fact, they have been accused in the press and by certain members of Parliament of directing the conspiracy to force metrication upon the country (The Bookseller, March 1971, p. 1662).

Characteristics of Metric Teacher Training in England

Impact of Teachers' Centres

One of the most significant factors influencing inservice teacher training in England has been the formation of Teachers' Centres. These were established through the influence of the Schools Council and the Nuffield Foundation. The Nuffield Mathematics Teaching project, which was linked originally to the Nuffield Junior Science Project, gave the final impetus to the establishment of the Teachers' Centres as they exist today.

In 1965, the Nuffield Project selected 14 pilot Centres for its mathematics program. Many other Centres, not selected as original pilot sites, became second phase Centres. Later, other local educational groups joined as "continuation areas." Finally, there were few LEA's not affected or involved.

By the end of 1966, there were approximately 90 Centres in operation. The Nuffield problem-solving approach of doing to understand emphasized foremost the workshop method of training. This emphasis continued and played a key role in later metric teacher training.

By 1970, there were 450 Teachers' Centres--largely under local control and, more importantly, to a large degree under teacher control. Although no two Centres are quite alike, several common characteristics run throughout all:

1. They are locally operated settings in which teachers can meet informally and freely discuss new objectives, new projects and new approaches; and participate in inservice training.

2. Often, the schools in the area surrounding the Centre are invited to try out new materials, with school staff contributing evaluations and suggestions for improvements.

3. Teachers identify areas of research and development in fields in which they are particularly interested and are assisted by the Centre in keeping informed.

The emphasis throughout all Teachers' Centre training is on classroom practices and strategies, and materials. Experienced and enthusiastic teachers play a lead role--much more so than they do in the typical institutes or summer sessions in the United States.

The rise of the importance of the Teachers' Centre preceded and paralleled the introduction of metrication in English education. Teachers' Centres were thus ready to assume a key role in staff training for metrication.

The network of Teachers' Centres in every area throughout England appeared to be of great value in offering meeting places for interested teachers to exchange ideas, and opportunities to plan training for their classes. Some Centres, above all, provided an opportunity for first-hand experience with metric equipment of all types. At these Centres, teachers meet to discuss problems, to plan metric exercises and to work with other teachers on materials problems in metric learning and teaching. An example of the variety of training activity during 1971 is illustrated in Figure 1. This represents a sample taken from a review of 100 Centres at that time.

It should be noted that the initial focus on metric teacher training had taken place some five years prior to our interviews in 1974. Metrication is now subsumed under or united with various modern mathematics approaches and no longer stands out as the key issue in teaching of measurement.

General Approach to Metric Teacher Training

In a number of Teachers' Centres planning sessions began in 1969, following the 1968 Royal Society report. These planning sessions studied the implications of metrication for schools and made recommendations for the local educational authorities. Frequently, they developed drafts of instructional materials and guides which were then published. These guides were widely distributed to other Centres and to LEA's, and

London Boroughs	Teachers Centres	Courses	Study Group	Workshop	Other
Barnet Brent Harrow	Teachers Centre	One meeting held			No further provision
Enfield	Enfield	One day conference held for all primary schools		Four workshops held	Exhibition of books and equipment. Film and discussion groups
Haringey	Haringey		Three study groups	A series of workshops	Exhibitions of books and equipment. Magazine – articles on metrication
Newham	Teachers Centre	Courses for primary and secondary teachers have been held – to be repeated	Working Parties on metrication in primary and secondary schools for teachers of craft, domestic science and commerce		Interim report of the primary school Working Party is available for all primary teachers
Sutton	Teachers Centre	Meetings held for handicraft teachers in secondary schools	Working Party of craft teachers to give advice on equipment	Workshops held with College maths lecturers	Little demand for maths and science courses
I.L.E.A.					
Abbey Wood	Mathematics Centre	Courses and conference			Standing exhibition of equipment. Special issue and articles in Teachers Centre magazine
Catford	Catford T.C.	No provision			
The Modern Language Centre		No	No	No	No
Hackney	Teachers Centre	Meeting of Secondary teachers in March 1971		Workshop for primary teachers in January 1971	
Wandsworth	Housecraft Teachers Centre	Seven courses held		One workshop held	

Figure 1. Example of metric activities in English Teachers' Centres as of 1971 (National Union of Teachers, 1971, p. 29).

formed a basis for initial teacher training plans and outlines. Many of the original working guides were felt of sufficient quality to be given broad dissemination throughout many schools in Great Britain.

During the initial period of metrication, metric materials were in short supply and many were pedagogically poor. One of the first functions of the Teachers' Centres was to collect and display useful equipment. Frequently, working parties attempted to examine and screen equipment before the display. However, quality control problems vexed them continually at this time. Centres reported that their initial exhibitions contained materials with manifest inaccuracies, obviously too easily broken or not easily manipulated by small children. Suppliers responded with increasing quantity and variety, and with some improvements in quality. However, the faults of the earlier equipment were still remembered with strong feelings by our respondents when interviewed years later. Most Centres reported good cooperation from manufacturers in delivering representative materials and making a wide variety available for teachers to examine.

It should be made clear that in most Teachers' Centres introductory training in SI was also part of training in general mathematics. Teachers usually came to learn new methods in mathematics, and metric units were used as part of the practical work. The Nuffield Courses in Mathematics and their methods were an important influence on training in SI. Later, the Nuffield Courses were supplemented more and more frequently by special courses on metric measurement.

No extra pay or incentives were given to teachers for attendance at the training. Notices of available training were sent to both primary and secondary teachers; however, the respondents were predominantly the primary teachers. The Centres found that primary teachers demanded more training than had been anticipated. Assistance was given not only in the Centres but followed up in the schools to help direct and organize working parties and to coordinate the curriculum used in the schools.

Our interviewers found no great emphasis on efforts toward the education of parents--only one Centre mentioned giving evening courses to parents. One Centre did mention that about 30% of the primary and infant schools in its area presented demonstrations for parents.

Staff Characteristics

Usually Centre wardens, teachers who had been working in mathematics and science workshops previously at the Teachers' Centres, and local mathematics advisors formed the metric training staff. Some Teachers' Centres also had a workshop technician who helped with the construction and conversion of equipment. Most of the staff, thus, had an appropriate educational background but had no particular training in metrication or SI.

Apparently, training staff were self-taught on their own time. Some of the staff had been in the various national courses run for Leaders in Mathematics. These courses had included some introductory work on metrication and measurement but no special training in SI.

Program Strategies and Methods

Many Centres attempted to run small-group workshops, with instructor/student ratios of about 1 to 10. Typically, in a large Centre a technician would supervise activities in the workshop, e.g., to show teachers how to convert available materials into metric devices. They would use cardboard, wood, paper, etc., substances easily found in a classroom. Centres were open during the normal school hours and after school. During the three-year period from 1968 through 1970, many of the primary schools were able to develop their own materials and equip themselves with sufficient metric apparatus.

It was found that the comprehensive demonstrations of equipment and software were quite popular with teachers and large attendances were reported. At this time, many of the Centres also began to offer courses in the construction of metric teaching equipment by the teachers. Such courses in teacher handcrafting of materials were rated by our interviewers as among the most useful training activities. Some examples of representative teacher-made materials are included in

Appendix A. The absence of available equipment of suitable quality gave continued impetus to the local design of teacher-made materials. Teachers' Centres became important agencies in this respect.

Some Centres also offered occasional lectures, usually delivered by heads of the Centres or members of local college staff. Considerable criticism was voiced regarding the lectures. Many teachers reported that the lectures were impractical, too academic and did not develop the skills needed for primary teaching instruction. The bulk of the training at the Centres was of a hands-on workshop type. Usually, attendance at the workshops was voluntary, although occasionally an LEA head or advisor would select the staff to attend. By and large, primary teachers comprised the major target audiences. It was the consensus in England that secondary teachers felt they could learn on their own or with minimal training. All varieties of teacher learning strategies were used: lectures, discussions, demonstration, exhibitions and practical workshops.

Although it must be cautioned that almost all training we are reporting had to do with primary school teachers, the continual emphasis was on a practical, direct measurement approach. Lectures and abstract approaches were eschewed by the target audiences.

Teachers were encouraged to measure themselves, the rooms and familiar objects. They were actually taught to do the very activities that they would later have the children doing in the classroom. A good deal of work was done on estimating distances and weights in metric and then checking by actual measurement so that the teacher would gradually "think metric."

Basically, the dominant approaches involved practical measuring and immediate problem-solving. Teachers became involved in assessing distances; first estimating them in metric units, then measuring them, re-estimating and measuring, etc. This was followed by analogous estimates and measures for volume and temperature.

Typically, sessions were after school for perhaps two hours a session. There were a few Centres which used crash sessions of two days,

but most favored a several-week program of two hours an evening. The frequent meetings for teachers, e.g., daily or twice a week, were sometimes accompanied by less frequent, once-a-month meetings for heads of mathematics departments or principals. These were usually a series of meetings concentrating upon approaches to mathematics rather than metrication, although the problems were expressed in SI units.

Many Centres which had produced guides, as noted previously, used them as part of an effort to summarize, review and to provide back-up training after the teacher had returned to school. These were frequently incorporated into planned programs in which the teacher returned to the school, experimented with the new strategies learned and equipment constructed at the Centre, and then returned to the Centre for subsequent sessions to discuss teaching problems and refine the approach and materials.

Courses in which instruction was done in alternating phases, e.g., Centre inservice followed by actual practice in the schoolroom, and then returning to the Teachers' Centre, were highly favored by most Centre staff interviewed.

Teaching Materials and Equipment

Exhibitions and Centre-constructed kits were a cornerstone of most teacher training. Several Centres developed fairly comprehensive kits for metrication. Teachers then came from other schools to learn how to make these kits. It was estimated at the T. F. Davies Centre that it took about six to eight weeks to make a kit. Thus, a teacher could be involved in sessions of three hours per week for several weeks.

Both teachers and Centres claimed that in the early years it was cheaper and better to make new equipment than try to convert the existing older equipment. As commercial equipment became of better quality across the years, the need for making metric kits was no longer as obvious. However, these courses were still continuing in 1974. One of their great advantages was that teachers teach themselves to think metric by measuring and making the equipment.

A number of teaching materials and guides were developed by Teachers' Centres and the Schools Council. The Schools Council is an independent body which has considerable influence on curriculum in British education. In vocational education, the booklet Measure for measure: A guide to metrication for workshop crafts and technical studies (1970) was of great use. The booklet Metres, Litres & Grams (1971) was widely disseminated to teachers in Britain's primary schools.

- Measure for measure: a guide to metrication for workshop crafts and technical studies. This booklet begins with a general statement on the advantages, transition phases, and training of teachers followed by a general program for change in metalwork, woodwork, and technical drawing. The schedule is divided into short-term, middle-stage and long-term changes.

  A section containing a narrative on the change in one school which had already occurred at the date of publication relates the activities engaged in by both teachers and students.

  Several appendices comprise about half the content of the booklet. These include information concerning SI usage, suggestions for projects and other educational activities and specialized technical information pertaining to drills, lathes, milling machines and other tools.

- Metres, Litres & Grams, Introducing metrication in the primary school. This well-illustrated booklet stresses the "tactile" activity approach to teaching the metric system to young children. Suggestions are given for "assignment work cards" in successive phases of learning.

  The illustrations include reproductions of children's work done in response to the work cards. One, in particular, depicts a plan of a classroom with various dimensions indicated in centimetres and a narrative description of some of the dimensions; for example, "the lady's toilet

door measures 60 cm wide and 198 cm high, ..."

The booklet also lists sources of information and publications useful to the teachers of primary students.

The T. F. Davies Centre for Teachers at Bradford developed a kit for metrication in 1968, and some 400 teachers came from primary schools during 1968-69 to make the materials in workshops held for this purpose. A photograph of the teacher-constructed kit is presented as Figure 2. The complete list of items contained in the kit is as follows:

1 metre rod marked off in cm or 10 cm

1 set of metric rods consisting of one each of
1 m, 50 cm, 40 cm, 30 cm, 20 cm - and ten 10 cm pieces

1 2-metre folding rod marked off in cm and 10 cm

1 wall fixing height measure - without slide
1 wall fixing height measure - with slide

1 free stand height measure - building blocks,
consisting of 1 m, 50 cm, ten 10 cm, two 5 cm, ten 1 cm pieces

1 50 cm caliper or head measure in cm
1 metre caliper measure
1 Mondopoint foot measure
1 trundle wheel, 1 m in circumference

1 set of ten 30 cm rules
1 set of ten 25 cm rules
1 set of ten 20 cm rules

Set of metric measuring equipment

Geoboards, etc. Logic Blocks Abacus

Balance
Bucket balance
Metric trolley and equipment

The construction of these pieces of apparatus gave the teachers invaluable experience in actual measurements within the metric system. Construction plans for the trundle wheel, the foot measure and the two height measures are shown in Appendix A.

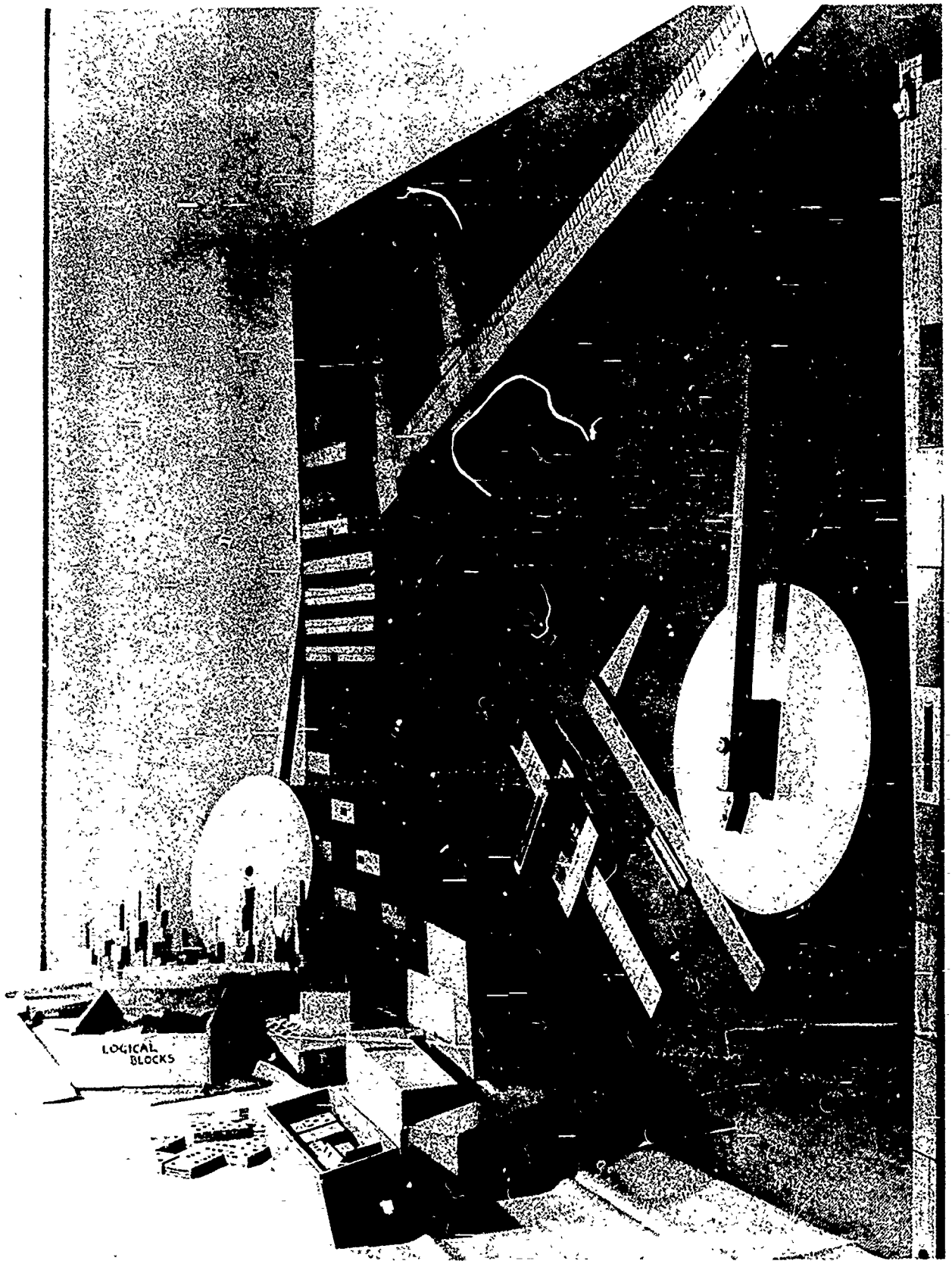

Figure 2. Teacher-constructed metric kit developed by the T. F. Davies Centre.

By U. S. standards, available monies for primary school metrication were not large. Centres reported that approximately $120-$180 per school were provided by LEA's for the construction or purchase of metric equipment.

At first, charts and pamphlets were in great demand but few suitable ones could be found for school use; nor, at first were there any reported useful TV or radio programs. Films developed by the Metrication Board were not considered appropriate for classroom needs. Although a number of general TV programs touched on metrication, no BBC or commercial TV producers ever made a teacher training program on metric. In 1972, the Audiovisual Centre of the University of Hull was commissioned to produce a videotape, "Learning Metric," which showed children, ages 8-11, learning metric measurement. This production was not highly regarded by teacher trainees. A later Government production, entitled "Simply Metric," was produced for general public use but no details on its use in teacher training were reported. In general, audiovisual materials did not gain wide use in the English classroom.

Many problems were found in initial commercially-produced equipment. For example, plastic rulers were too brittle, and often became warped and not true. Imperial rulers converted by taping off the ends and relabeling were common but very unsatisfactory. Manufacturers began selling rulers twelve inches long marked with 30 centimetres; however, many teachers wanted rulers either 20 or 25 centimetres long because these would be the exact divisions of 100 centimetres or one metre. Plastic measuring devices often contained numerals of the same color as the background material so that they were scarcely legible.

Finding proper liquid measures was difficult at first. Small children were confused if water in a so-called litre measure did not come to the top when a litre of water was poured into it. Furthermore, in teaching students in early grades about capacity it was thought necessary to have containers of the same volume but varying in shape. This was difficult because there were no readily available containers in metric sizes.

Many other instruments had improper and unreadable measurements, and furthermore, were inaccurately calibrated. In fact, on some rulers the numerals were not opposite the calibrations. Practically all teachers confirmed that adhesive tape or other markings used to convert old imperial equipment was not found to be satisfactory. Furthermore, mass pieces (weights) accompanying balance scales were often inaccurate.

Program Results

Evaluation reports of training were scarce. Teachers' expressions of enthusiasm and self-reports of subsequent success in the classroom appeared to constitute the usual evaluation. Our interviews identified no instances of any reported comprehensive process or outcome evaluation.

Teachers did report that the children were taught to think metrically and could use the units. Most teachers reported favorable attitudes, motivation and practical participation. Despite the multitude of guides and materials sold, there were no published reports of evaluations of materials, software or training.

Teachers themselves reported that the metrication kits, the exhibition of materials, the actual hands-on using of equipment and participating in direct measurement were the most helpful things in their training. Teachers reported that when they returned and shared their ideas with the children, using the same measurement methods they had been trained in, teaching was successful and a valuable reinforcement to their training.

Teacher Training Problems

A continuous problem was that the teachers felt let-down as it became obvious that the school was progressively surpassing the consumer world in conversion. A lesser, but nevertheless vexing, problem was that most courses were held on a voluntary basis after school. Teachers voiced the usual complaints of fatigue and the unfairness of overwork.

Teachers of small children felt that they had many problems with the sizes of SI units. For example, the millimetre was too small and

and the metre too large. In a sense, something closer to the old imperial units was better related to the sizes of the real world for a small child. A kilogram is too heavy but a pound is comfortable for him. What child can drink a whole litre? This problem very likely resulted from British preoccupation with preferred SI prefixes (milli and kilo). In actual practice teachers can alleviate these problems by the use of units such as centimetres, decimetres and decilitres in the instruction of small children.

Another problem was that metric units were neither written correctly nor converted properly. Symbols were often incorrect. The weight-mass confusion often remained unclear; and as an issue, it was frequently postponed by many instructors. At the primary levels it was too difficult to teach for most teachers. There were also problems with over-precision, such as a 1.03001 litre. Teachers reported that children find it difficult to work with several units behind the decimal point. There was also considerable confusion about the terms "Celsius" and "Centigrade".[2] Teachers then confounded this problem by not grasping the correct notation of SI units.

Most teachers reported that the training lectures had been of doubtful quality, and their own time would have been much better spent in practical work.

In the initial stages of training both the low quality and unavailability of training materials and equipment presented problems. There was much concern about how to select good metric equipment. A frequently voiced complaint was that there were no adequate guides, advice or standards on how to evaluate and select metric materials. An early problem in the teacher-produced materials from the Teachers' Centres was the amount of variability in materials from Centre to Centre: variability in quality and in notations used.

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[2]The centigrade scale was officially renamed the Celsius scale by the International Bureau of Weights and Measures in honor of the Swedish astronomer credited with its invention. The name was changed to avoid confusion with a system used in some countries of dividing plane angles so that 100 grades = 1 right angle.

In retrospect, many instructors felt it would have been better if the training courses had been compulsory rather than voluntary. Most instructors felt it would have been better to run short courses over a period of time so that teachers could have experimented in the classroom with new methods and then returned for further instruction.

Many teachers were initially anxious about metrication, and did not think metric, initially or ever. The uneven nationwide approach in England made them feel even more insecure. This was one of the chief problems of getting teachers to attend courses when they had realistic doubts of the national goals and schedules.

Special Problems in the Crafts and Vocational Areas

These areas had special problems in the metrication of the machines which had to be converted several years in advance. They needed special funding and this was very costly. Many lathes, however, were reported to be converted at a cost of about $120 each.

Strangely, there were no reported inservice training programs in metrication for the shop teachers involved. Many of the older shop teachers were especially anxious and resentful. In fact, they became negative toward metrication and learned as little as possible.

In a major training effort, technicians from the Educational Equipment Centre of the Inner London Education Authority were sent to the schools with metrication kits to convert the equipment; the teachers were then shown the calibrations by these technicians. This was actually the only training these teachers received. If they requested further help, the technicians returned. One of the great difficulties which all shop teachers faced was that metrication in the outside world was never complete, so stockrooms became a confusion of sizes and dimensions, a haphazard conglomeration of two inconsistent universes.

Many of the reporting staff felt that the handicraft teachers survived the change, but just survived. Many did not receive adequate inservice training courses. There were two needs that were not met: adequate planning and financial resources early in the process, and the provision of the necessary training.

Frequently, shop teachers did not know what new equipment had to be ordered nor the appropriate sizes. Finally, as industry began to clarify their own requirements the selection of materials and equipment for the school shop became clearer. A few exhibitions of metric shop materials were staged in 1969 and 1970, and to these the response from shop teachers was tremendous. Teachers were, for a rare occasion, able to look at wide ranges of samples of materials and catalogs.

Home economics teachers were, and still are, beset by many problems inasmuch as the consumer world in Britain was the last to begin converting and has not gone metric yet. Most cooking ingredients and containers are still sold in imperial units. Although the new recipe books are using metric measures, it hasn't seemed practical to alter all the old recipes. Dual-dimensioned scales were tried but generally rejected as hopeless. Cake tins remain imperial, and on ovens and ranges Fahrenheit is still being used on the temperature gauges. For home economics training purposes, Celsius scales are sometimes pasted over these.

Our interviewer was able to obtain the most complete report on home economics teacher training from the Gordon Home Economics Centre. The Centre received numerous requests for workshops from teachers, especially older teachers. Courses developed in response to teacher requests tended to attract secondary-level home economics teachers. The typical class size was twenty, with three instructors.

The Centre produced an influential publication, Metric Measurement in Home Economics (Gordon Home Economics Teachers' Centre, no date), which was distributed to many teachers in Great Britain in addition to those who attended the training sessions.

One special problem mentioned was that home economics departments had been given allowances for metrication equipment and materials before they were trained. In these early stages, the teachers found it difficult to determine what equipment would be needed. To date, some home economics textbooks have gone metric, many have not--a disturbing dilemma to teachers.

The textile trade has been one of the last major industries in Britain to go metric. Dual measures are still given in most sewing patterns. However, home economics respondents report they can and will adjust to the world, if it ever becomes metric.

General Views of English Respondents

English respondents were asked to summarize their general views on metrication and what we could learn from their experiences. Their comments focused on three areas: scheduling, staffing, and training strategies.

Scheduling

Many teachers felt that a session of two or three hours a week for perhaps eight weeks was better than a more intensive crash-training course. Teachers should be able to try out ideas, evaluate their training and materials and return for further work. A recommended timeframe for sessions was: practical work for about two hours, a discussion of the work for about an hour, and a lecture of five minutes or less. In the opinion of our respondents, teachers need released time for metric training. Unfortunately, in England such training was frequently conducted after hours and at night when teachers were tired.

Staffing

It was suggested at some Centres that sufficient time and staff be made available to check on how well the teachers have been learning. In training plans, teachers were to be paced through the same stages as they were to take the children through, but there was no staff observer to oversee the teachers' work. Training staff should include many advisors but few or no lecturers. Teachers affirmed their need for advisors to be constantly available so that they could continually discuss problems as they started and went through training.

Training Strategies

The major expressed conceptual need for training of teachers was for direct familiarization with the units. This involves estimating

length, area, capacity, mass and temperature in metric units; then checking with exact measurement until useful approximating becomes second nature. In practice, this means consistent and continued practical training. Most teachers reported that workshops including sessions where they were involved in doing things together in small groups and then discussing them, and were not lectured at, were popular and productive, in retrospect. The emphasis on practical and personal experience with the new units was continually reaffirmed.

There is a great need for help with anxiety reduction, especially for older teachers. They, and all other students, need to learn to think metrically in the world, particularly amidst the confusion of the nonmetric or partially metric consumer world.

ANALYSIS OF AUSTRALIAN EXPERIENCES

Introduction

Overview of Australian Metrication

In the late sixties, an Australian Senate Select Committee on the Metric System of Weights and Measures made an extensive survey of the practicability and desirability of early adoption of the metric system. Support for the change was expressed by educators, industrial representatives, retailers, consumer organizations, professional groups and government.

In March 1970, the Minister for Education and Science introduced the Metric Conversion Bill in the Commonwealth Parliament. The bill's objective was to bring about progressively the use of the metric system of measurement in Australia as the sole system of measurement of physical quantities. The target date for 70% metrication was 1976.

After debate in both the House of Representatives and Senate, the Metric Conversion Act of 1970 received Royal Assent on 12 June 1970.

In fulfillment of one provision in the Act, a Metric Conversion Board (MCB), ultimately consisting of fourteen members, was appointed on 1 July 1970. The Board is responsible to the Minister for Education and Science for the conduct of the conversion. The main task of the Board is to help ensure the success of conversion in different sectors and to coordinate the conversion program through close consultation with the parties concerned.

One of the functions and powers conferred on the Board was to set up committees to report to the Board on specific aspects of conversion. Eleven advisory committees, each chaired by a Board member, controlling some eighty sector committees, were appointed, comprising over 600 experts in all areas impacted by metric conversion.

The Australian Educational System

Basically, Australia has six separate educational systems, one for each of the states. The number of years spent in school, and the

examinations taken vary in detail. Generally, one spends about six or seven years in primary school, and an additional five or six years in secondary school. At about the age of sixteen, usually associated with a state-wide examination, students have the option of continuing to study secondary school subjects, changing to a technical or apprentice course in a technical school, or leaving school to begin work. Technical schools train both secondary and post-secondary level students. For those who stay in school there is a final examination which generally occurs at the age of seventeen or eighteen.

Within each state, the educational system is highly centralized, with all important administrative decisions being made in the state capitals. Currently, Australian departments are in the process of decentralizing, but when compared to American school systems would be considered highly centralized during the period when inservice training for metrication was in process.

There is also a network of independent and religious schools in Australia, some of which are the schools with the highest prestige and most expensive tuitions. Generally, they take their lead from the state in which they are located in matters of educational policy and curriculum and sometimes receive direct support from the state. In any case, their students have to take the state examinations and this ties them to the state curriculum to some extent. Teachers in these schools are often members of the same associations as teachers in the state educational system. For purposes of this report, this group of schools was not considered because the information available indicated that they had developed no unique inservice training programs of note for their teachers.

Metric Education in Australia

The MCB Education and Industrial Training Advisory Committee was established with sixteen members, attention being given to all education authorities and to the major interest areas of education. It was emphasized to each person that he or she was not serving as a representative of any region or group. However, members were chosen so that their

association with both regions of the country and areas of education maximized the degree of contact between committee members and various bodies involved in education and industrial training. For example, a member from Tasmania had extensive contact with home economics education associations, while a member from West Australia was involved with adult education.

While this committee, as the others, was advisory, it did serve as a useful forum for exchange of information, establishment of consensus, and recommendations for policy and action by the appropriate agencies. Information and advice for teachers often came directly from organizations established at the state level. For example, within the Education Department of Victoria a policy committee for metric conversion existed as well as curriculum committees for the various subjects at the different levels of education.

Assisting the Education and Industrial Training Advisory Committee were seven sector committees, each covering a specific area of education: primary, secondary, tertiary (university), tertiary (non-university), technical, adult and industrial training.

Since the members of these various committees were, or had close contact with, those who had the responsibility for planning and organizing the conversion in their various states and branches, by the time a plan for conversion in education had been put forth, it had already met with the approvals necessary for its implementation.

That plan, in brief, was that the curricula in primary schools should become fully metric as early as possible in 1973 and that a start on metric conversion in secondary schools should be implemented as soon as possible and not later than 1973, with the aim that secondary schools be solely metric by the commencement of the 1974 school year. A rather lengthy conversion program was anticipated in some technical school subjects at the postsecondary level because of the conversion of engineering and mechanical equipment, changes on lecture notes and worksheets, and the large amount of material for correspondence courses. Nevertheless, this conversion was expected to be completed

by 1976 (Metric Conversion Board, 1973b). This was the framework within which the state education departments worked for metric conversion.

While technical schools, in general, were scheduled to begin conversion in 1974, some got off to an earlier start. An example is provided in Figure 3, showing a proposed detailed schedule for technical schools in the state of Victoria.

Characteristics of Metric Teacher Training in Australia

Program Descriptions

The Metric Conversion Board in Australia was not responsible for any teacher training per se. Rather, such training was the responsibility of the various state departments of education. The Board, nevertheless, exerted a major influence inasmuch as the plans and schedules of the Education and Industrial Training Advisory Committee and its sector committees were integrated very closely with the educational plans of the various states. Furthermore, the many publications of the MCB provided the backbone for most of the activities conducted at the state level.

Queensland. Of the individual state programs analyzed, one of the most thorough was that of Queensland. Their main approach to inservice teacher training was to make use of an already existing network of school inspectors and advisory teachers who traveled throughout their respective regions conducting small workshops to familiarize teachers with metric units and with the sort of activities that they would use with their children.

Plans for metrication were formulated in three phases:

1. Inservice training of teachers.
2. Distribution of metric equipment to schools to assist teachers in introducing metric units into their classes.

STAFF TRAINING

1. Form Education Department Metric Conversion Committee
2. Examine requirements for staff training
3. Replace/procure office typewriter metric characters
4. Prepare film strips and short course materials
5. Investigate, locate and book 16 m/m metric films
6. Arrange and conduct seminars and courses for key personnel
7. Arrange and conduct in-school courses and seminars for staff

CURRICULUM

1. Examine and modify syllabuses
2. Prepare lectures in S I Units:
   (a) Trade courses
   (b) Certificate Courses - first two years
   (c) Certificate Courses - final years
3. Secondary schooling
4. Examinations: (a) Trade
   (b) Secondary and other

TEXT AND REFERENCE BOOKS

1. Examine textbooks and reference books for S I requirements
2. Select replacement books - discuss with book sellers and/or publishers
3. Purchase S I replacements

TECHNICAL CODES

1. Purchase - replacement standards, regulations, by-laws, etc..

CLASS NOTES

1. Modify using insert sheets - or re-write class notes
2. Print re-written class notes

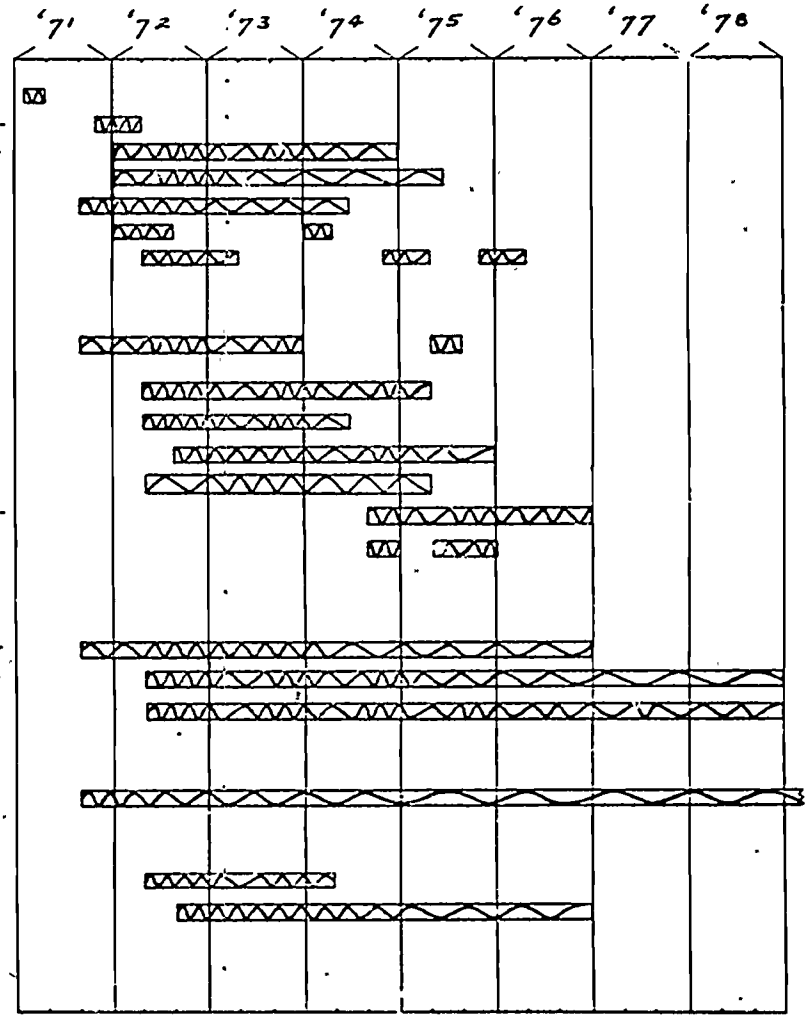


Figure 3. Metrication program for technical schools proposed by the Education Department of Victoria.

TEACHING AIDS

1. Investigate range of marketed replacement aids. ----------
2. Discuss replacement/original needs with suppliers. ----------
3. Prepare/construct replacement aids - within schools/departmental service centre(s). -

WORKSHOP/LABORATORY EQUIPMENT

1. Modify existing equipment. ----------
2. Replace minor equipment. ----------
3. Replace major equipment. ----------

WORKSHOP DRAWINGS AND OTHER TECHNICAL DRAWINGS

1. Prepare new drafts and modifications of existing drawings - teachers. ----------
2. Modify some existing drawings, prepare and print new drawings - departmental ... service centre(s).

CORRESPONDENCE LESSONS

1. Examine existing lessons to determine extent of modification/re-write. --------
2. Modify lessons as interim measure - including prepare and print errata sheets. ....
3. Revise, re-write and produce replacement lessons. ----------

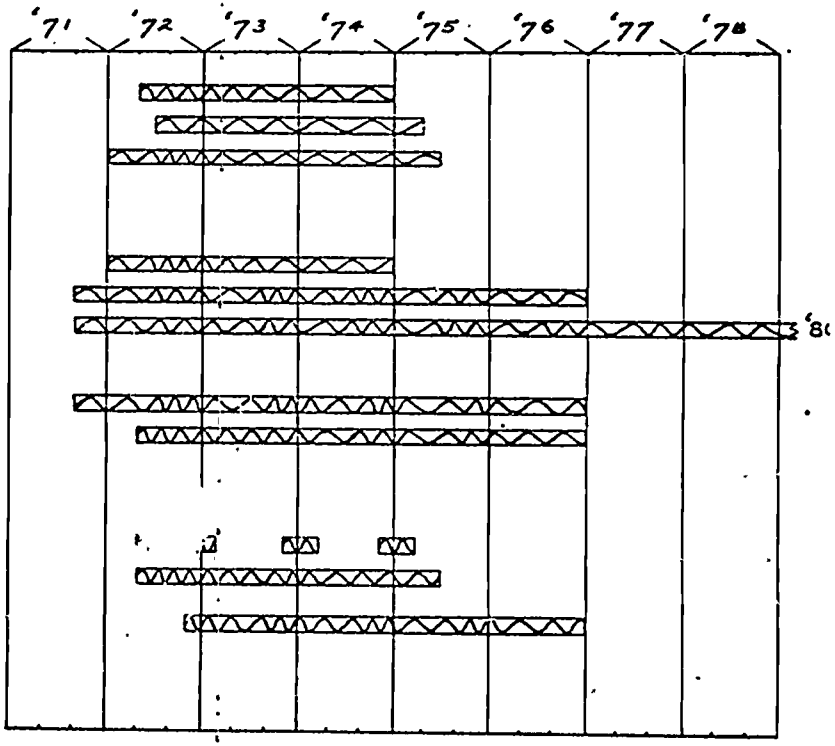


Figure 3 (continued).

3. Issuing of additional textbooks which use metric units and the revision of existing syllabi to incorporate changes brought about by metrication.

These workshops were oriented around an inservice training kit called "Let's Go Metric." Plans for this kit were formulated during 1971 and 1972. Its use was begun in May of 1972. A description of the kit will be provided later in this report.

This sort of workshop approach was intended to help teachers become interested in metrication, acquire practical knowledge and overcome any fears they may have had. The role of the workshop leader was to provide the materials needed, arrange them into comfortable work settings, stimulate inquiry through the activities, promote discussion, develop skills and consolidate these efforts by having participants work through the quiz. Summer school sessions of one week's duration were held during 1972 and 1973.

The kit was designed for use with about eight teachers for a 3-1/2 hour period, but this was varied as needed. After arranging the room, leaders were advised to give a talk on the metric system of about 15 minutes duration. The suggested source was the MCB booklet Metric Conversion for Australia (MCB, 1971), two copies of which are included with the kit. Then, for two hours, teachers working in pairs would work through the activity cards. The activities can be performed in any order so that not all teachers would be using the same material at the same time. The next half-hour was to be spent with the teachers working through the formal exercises, checking their answers as they were completed. After this, a half-hour was spent working through the self-check quiz, "Try Your Metric Knowledge" (Queensland Education Department, 1972) with teachers, again, working in pairs. The last quarter-hour was scheduled for a summary talk and questions, organized around the quiz.

Teachers were encouraged to follow up this work on their own. Such follow-up work could include: changing the syllabus to the equivalent metric units, developing children's activities, collecting books with

appropriate metric activities in them, converting suitable exercises from imperial to metric units, and working with metric activities with children.

New South Wales. The New South Wales inservice teacher training program was directed by the Metrication Committee of the Department of Education, some of whose members were also on various MCB committees. Generally, the inservice teacher training aspect of metric conversion was closely associated with syllabus revision. Some syllabi were specifically revised for metrication and, for others, advantage was taken of revisions already in progress. The alerting of teachers to these changed syllabi and the training of teachers to implement them properly was the main road to inservice teacher training in this state.

In addition to syllabus revision, the department distributed metric materials to the schools, including such materials as measuring sticks, tape measures, mass-pieces, measuring cups and trundle wheels.

There were also a few short courses given for primary teachers. In New South Wales, as in other Australian states, the Inservice Training Branch sees its function as responding to the demands placed on it by teachers and administrators. Demands do not often come from administrators. When a group of teachers in a section of the state feel a need for a course on a certain topic they request that the Inservice Branch organize it. The Branch then canvasses the need, and if it seems practical arranges for someone to teach the course. This someone may be an Inspector of the Department, or a local person who is capable of filling the need expressed by the teachers who want the course. The Inservice Branch generally does not provide any further resources for, or control over, the course. The exact number and kinds of courses given that were relevant to metric conversion could not be ascertained. Officials of the Inservice Branch feel that they were few in number.

In the case of metric conversion, the Inservice Branch anticipated that it would be called on to provide an extensive set of courses over the entire state, aimed at all teachers affected by metrication. Before discussing what actually happened we will discuss what these courses would have been like.

The courses, as far as they were planned, would have taken place in all the major population centers of the state and would have been about 35 in number. Each was to be about eight hours in duration, this time being spent in two- or three-hour periods after school for three or four evenings of one week. There was to be a short lecture on the metric system, and the reasons for it--perhaps a film. This would be followed by discussion and a workshop where teachers would get a chance to work with metric materials and practice examples of the exercises which they could use for their students. Before, during and after these courses there were to be on display examples of metric resources available, including publications and classroom materials.

Neither the decision from higher authority, nor the demand from teachers that would have made this statewide series of courses necessary ever materialized. The plans were never implemented and the material and resources which had been accumulated were abandoned.

In a few areas small groups of teachers did request courses on math teaching, including metric measurement. Most of these were given by an Inspector of the Department, and were similar in format to the one just described. This was given over five two-hour sessions, each session being given in a different week.

In addition to the materials especially prepared for primary teachers, and the adaptation of courses developed earlier, officers of the Department of Education feel that most teachers learned most of what they knew about SI from the publications and publicity of the MCB.

So far, the major secondary inservice teacher training effort for New South Wales has been the presentation to mathematics teachers of material on the metric system from the MCB and the development of problems for students to work out as exercises. This presentation was mostly done as part of the revision of the mathematics syllabi. Some courses were given in various parts of the state on these new math curricula, and problems or questions of metric units and metric education may have come up during them; but officials of the Mathematics Curriculum Section and the Inservice Training Branch have no reason to believe

that such concerns were very large in those courses. While these courses covered metric units that had been included in the revised syllabus, metrication was not a major focus.

One of the reasons why more requests for inservice courses on metric units were not received from secondary teachers may have been the resourcefulness of some school principals in making use of kits distributed by the MCB to provide resource material for adult education. To understand this kit and its place in inservice teacher training we need to consider the Adult Education Sector Committee of the Education and Industrial Training Advisory Committee of MCB.

The Adult Education Sector Committee of MCB decided to develop a kit of materials which could be used as a resource for those involved in adult education, including those who gave talks to social and service clubs, training officers in industry, etc. The kits were assembled and distributed to centers around the country where they could be borrowed by such prospective adult educators. These centers were often libraries, especially technical college libraries. They were also sent to the area offices of the New South Wales Education Department.

From there, the principals of some high schools decided to use them as the basis for inservice training for their teachers. It is clear that this "Metrikit," as the Advisory Committee called it, played a role in the inservice training of teachers for metric education in New South Wales. This kit is described later in the report. The Metrikit was issued in mid-1973 and was probably used for teacher training in late 1973 in preparation for secondary metric education in 1974.

Victoria. Conversion at the primary level was mainly effected by the introduction of a new primary mathematics curriculum in late 1972. This course uses only metric units in its formal measurement sections. As far as we were able to discover, there was no special effort to acquaint teachers with metric units as such. However, the department did two things which aided teachers to use the new curriculum effectively. They published two circulars, entitled "Introduction of Metric Units" and "The Influence of Metric Units." These circulars assume

knowledge of SI and are intended to help teachers use SI units in their classrooms. The second part of the effort was to provide equipment for the some 2,000 primary schools. This consisted of trundle wheels, litre-sized cubes, rules, etc., and material to provide workshop activities in measuring. Teachers could of course use this equipment along with the students (or before they did) in learning to think metric. There is no clear evidence of the extent to which this was done. No pattern of activities was suggested for use with these new materials other than those activities already in the curriculum. Generally speaking, the material for adult education was viewed as quite adequate for teacher training at the primary level.

One of the functions of the Curriculum and Research Branch is to maintain a staff of executive officers in specialized subjects and general primary education. These officers provide advice and assistance on problematic issues to teachers who request aid. They also, from time to time, assemble notes and materials and send them in the form of circulars to appropriate teachers. Generally, however, this branch sees itself as a service organization which responds to expressed needs rather than attempting to anticipate them. They ascertain the degree to which te. ers feel they need help in certain areas and the kind of help they need from requests they receive from teachers and the urgency of the demands. Few requests for help on metric conversion have been received, and consequently little in the way of conferences and workshops actually took place.

For secondary education in Victoria the approach consisted of a seminar for key people, who were then to act as guide people for their subjects and regions during stage two. There was follow-up work by the Curriculum and Research Branch as appropriate for particular subjects.

The seminar for key guide people was held on April 26 and 27, 1973. It was called "Metric Conversion within the Sphere of Education" and was billed as a "Seminar for Group Leaders in Basic Subjects." It was attended by about 180 people who represented one teacher from each of the subjects affected by metric conversion at the secondary and technical levels in each of the State Education Department's eleven

geographical regions. The people selected were deemed representatives of their subjects in their regions. They were mostly nominated by the principals of the more important schools in each region, and were usually the heads of their departments.

Because Curriculum and Research has a subject matter specialty orientation, different types of material were prepared for different subject area teachers, so as to provide them with the most useful material for their concerns. Math and science were seen as the least problematic areas.[3] The more practical subjects were seen as the most troublesome. Thus, more attention was paid to helping teachers in these subjects.

Tasmania. Conversion of the Tasmanian Education Department to the metric system was coordinated by an intra-departmental committee. This committee saw its functions to be the following:

1. Collect and disseminate information on metric education.
2. Organize seminars for inservice training.
3. Provide ongoing information to schools and teachers.
4. Ascertain what commercial equipment was available, appraise it according to the standards of the MCB and according to educational standards of Tasmania, and arrange to demonstrate that which passed in Teaching Aids Centres.
5. Initiate distribution of basic metric measuring equipment to primary schools.
6. Maintain a supply of materials such as slides, charts, booklets, which could be borrowed by teachers.

[3] While this view is rather common, experienced science educators have voiced the fear that we are underestimating the task of converting science teachers who have fundamental and far-reaching changes to make. Physics teachers, for example, must forsake a number of traditional units, e.g., erg, dyne, and kg force.

Because of the differences in backgrounds and needs of teachers at different grade levels and in different subjects, various approaches were taken to inservice training.

All primary teachers in Tasmania participated in a series of seminars on the metric system and metric education. These were held toward the end of the 1972 school year, as close to the time when the information would be needed (early in 1973) as practicable. These were organized by the superintendents of the various districts. Each one was one-half to one day in length and took place as part of a more extensive workshop which was devoted to "activity learning." A seminar included from 50 to 75 people.

In the metric seminar all the participants gathered together for an introductory session. This lasted between 45 minutes to an hour and covered the reasons for Australia's conversion, the differing metric systems and a discussion of SI, and some comments on the idea of measurement as a concept.

The presentation also included a discussion of the pattern of SI; the base units, the multiples, the common prefixes, etc. As well as being intended to convey information, this session was designed to convince teachers that SI was simpler to use and to teach, and that the simplicity made the transition worthwhile. It was also intended to overcome any fears about the new system that teachers had. The examples which were given included the units for everyday experiences that people would have with metric quantities such as bags of sugar, loaves of bread, etc.

The discussion afterwards, aside from general concerns about SI, often focused on the place of the new units in the curriculum and how the conversion might affect other aspects of the curriculum such as common fractions and rational numbers.

After this, teachers broke into small groups of about 10 to 15 people each and engaged in some activity learning. For this they used the basic metric equipment which was to be provided to schools according to the directions specified on a set of activity cards. The

purpose was to have the teachers engage in the sort of activity by which their students would learn. These activities, along with the material used to perform them were designed and chosen by the Metric Conversion Steering Committee working with a group of teacher consultants. The teachers designed the activity cards, and advised on the type of equipment needed. An example of the activity cards is shown in Figure 4. Others are included in Appendix B.

These kits and activity cards which the teachers worked with during the activity period of the seminar were the same as those sent to schools. One kit was sent for about every 125 students, or one for every four classes. It is considered important by those in charge in Tasmania that teachers had a chance to engage in the same activities they would be assigning to their students.

The Queensland self-test, "Try Your Metric Knowledge" was considered for use at the end of these seminars, but was rejected because of the purpose of the seminars, which were seen not as instructional in the metric system so much as sensitizing and providing resources and direction for further work on the part of the teachers. Most of the study of the facts of the metric system was expected to be done after these seminars. Thus, any sort of test was considered inappropriate at this stage.

A different approach was taken with most teachers at the secondary level. This varied according to level of previous experience and involvement with the metric system.

In general, the approach with secondary school teachers in Tasmania consisted of two stages. In the first stage, a specialist teacher was selected from each secondary school to be metric coordinator for that school. They were selected primarily because of previous knowledge of a metric system, even if not SI. They were mostly science teachers, but some taught mathematics and a few other subjects. These teachers had already been using a metric system in their teaching. The coordinators were to function as resource people in their schools--as a funnel, passing on appropriate information to their colleagues. The Department did several things to aid them in this task.

LENGTH

Needed: A tape measure.

Work with a friend.

1. Measure and write down the width of your thumb and palm, and the length of your span and cubit, your reach and your height.
   Note: The reach is the distance between the fingertips when the arms are outstretched sideways.
2. Study these measurements. Can you find any that are half of or twice another? Are any nearly the same?
3. Choose two friends of different sizes and write down their measurements in the same way.

NAME	THUMB	PALM	SPAN	CUBIT	REACH	HEIGHT

4. What do you notice about the cubit and the span of one of your friends?
5. Can you notice something about the height and reach of one of your friends?

Figure 4. An example of the activity cards used in Tasmanian teacher training workshops.

First, it held three one-day seminars for metric coordinators. There are about 35 high schools in Tasmania, but since technical college coordinators attended the same seminars, there were about 10 to 15 people at each. Th e seminars were held as informal discussion groups. There was no formal presentation and very little in the way of a formal program. They did start out with a discussion of the printed material available, what it contained and how it could be of use to which teachers. Since these were people who had been specifically selected because of their knowledge of a metric system (not necessarily SI), there was no need to present them with basic information in a lecture or activity-learning format. The primary reasons for the seminar were to sensitize these key people to their tasks in the schools, prime them with sources of further information and then discuss with them tactics of carrying out their task of coordinating metric conversion in their schools.

Coordinators were encouraged to engage in more general activity to publicize metric conversion in their schools. The exact way in which they did this was left to them, but various strategies were discussed at the seminar. The strategies actually adopted varied. Some put up displays and encouraged other teachers to study them and seek out additional information. Other coordinators spoke to staff meetings of the school to familiarize teachers with the changes necessary. Some spoke to the whole school at assembly, thus achieving the double effect of alerting teachers and beginning the education of students.

Teaching Materials and Equipment

While the various Australian states generally used some form of kit in their teacher training activities, most noteworthy of description is the kit developed by the Metric Conversion Board, titled "Metrikit" and the one developed by the Queensland Department of Education, "Let's Go Metric."

Metrikit (MCB, 1973). This kit was designed to provide resource material to adult educators, and not as a self-instructional aid; although it could be used as such in a limited fashion by speakers preparing for an audience.

The major items in the kit are:

- "Metrikit Speakers' Notes," designed to be read while placed on a table or podium by a standing speaker. Speakers are advised not to attempt to cover everything at once; rather, one should choose material from the kit relevant to the interests of the particular audience. Emphasis is placed on the encouragement to "think metric" and speakers are told to stress the point that activities involved in measurement are the same in metric units as in imperial units and that there is nothing to fear from conversion.

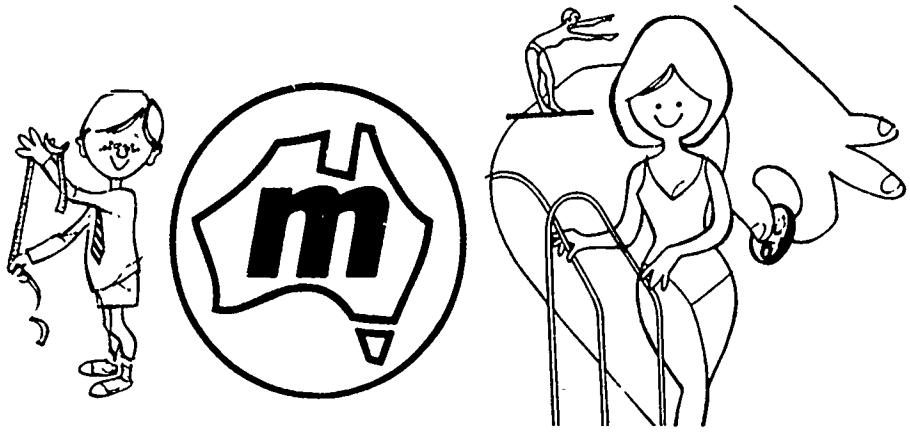
  Various lecture outlines on specific subjects are included; e.g., (a) advantages of the metric system; (b) mass; (c) cookery; (d) information for handymen, farmers and shoppers (consumer protection); and (e) the proper usage, expression and spelling of units and numerals.

- Items of background data which include the MCB publications, Metric Conversion for Australia (1971), Metric Conversion and You (1972), Metric Practice (1973a), and Industrial Training for Metric Conversion in Australia (no date).

  The first two publications were cited most often by the educators interviewed and will be described later. Other items include a list of "Tentative Dates for Metric Conversion" and four posters for display purposes. Figure 5 illustrates the poster entitled "How Long?". Other posters covering volume, mass, and area are contained in Appendix C.

- A series of data sheets for reproduction as audience handouts with subjects such as: (a) SI Base Units and Prefix Values, (b) Some Metric Units and Their Symbols, (c) A Metric Measurements Style Sheet for Typewriting, etc. The last handout is a self-check test with questions covering the simpler units and measures discussed in the lectures.

- A set of 36 slides keyed to particular sections of the Speakers' Notes.



HOW LONG?

MICROMETRE (μm), MILLIMETRE (mm), CENTIMETRE (cm), METRE (m), KILOMETRE (km).

METRIC PREFIXES kilo (k)—means thousand milli (m)—means thousandth
centi (c)—means hundredth micro (μ)—means millionth

10 mm = 1 cm; 100 cm = 1 m; 1000 m = 1 km

80 μm	**About the thickness of a human hair**
1 mm	**About the thickness of a five cent piece**
2 mm	**About the thickness of a match stick**
1 cm	**About the width of an index fingernail**
25 mm	**About one inch**
10 cm	**About the width of a man's fist**
1 m	**A long pace**
50 m	**Length of an Olympic swimming pool**
8 km	**About five miles**

CONVERSION TABLE: 1 yd - 0·9144 m (exact) 1 n mile - 1852 m (exact)

Approximate values: 1 in - 25·4 mm - 2·54 cm (exact); 1 ft - 304·8 mm - 0·3048 m (exact); 1 yd - 0·9144 m (exact); 1 fathom - 1·829 m; 1 chain - 20·12 m; 1 furlong - 201·2 m; 1 mile - 1·609 km

Figure 5. Example of MCB poster used in Metrikit (MCB, 1973).

- A set of equipment aids including tape measure, a plastic sheet (one square metre in area), metric measuring spoons and a cardboard cube (one litre in volume).

Queensland inservice training kit, titled "Let's Go Metric." As we have noted, Queensland's main approach to inservice teacher training was to make use of an already existing network of school inspectors and advisory teachers to conduct small workshops. These workshops were oriented around the "Let's Go Metric" kit formulated during 1971 and 1972 and put into service in May, 1972.

The pivot point of the kit is the publication designed to accompany it, entitled "Let's Go Metric Handbook" which was intended to guide the workshop leaders. In this booklet, the role of the workshop leader is discussed. The topics presented, and the activities assigned to teachers, are emphasized as starting points only, providing bases for teachers to develop their own approaches.

Printed material in the kit includes teacher activity cards, formal exercises, "Try Your Metric Knowledge" booklets (Queensland Education Department, 1972), publications from the Metric Conversion Board and student activity cards. Also included is a set of overhead projector transparencies for the concluding quiz.

Hands-on equipment include such items as rulers, measuring tapes, mass sets, balances, graduated cylinders, etc.

Australian Metric Conversion Board publications. Materials prepared by the MCB played a large part in the training of teachers. Probably the two most important publications were Metric Conversion for Australia (MCB, 1971) and Metric Conversion and You (MCB, 1972). Brief reviews of these publications are as follows:

- Metric Conversion for Australia is the basic document of the MCB on which most of the others are based. It discusses (1) the background to metric change; (2) the steps to the decision for conversion; (3) the advantages to accrue from conversion; (4) the history of the metric system and SI; (5) the general organization of the MCB; (6) metric

units, both basic and derived with charts of their names and symbols; (7) proper usage of metric units; and other miscellaneous information.

- Metric Conversion and You (MCB, 1972) was probably the teachers' main source of basic information on the metric system and the single most important publication directed toward adult education attempted by the MCB. Toward the end of 1972, a copy was deposited in every mailbox in Australia. The cover includes the admonition "Keep this book for reference."

  Included in this publication are the following:

  (1) map of metric and non-metric countries
  (2) history of metric conversion in Australia
  (3) discussion of the rationale for conversion
  (4) discussion of metric units for everyday use, including correct pronunciation, spelling and usage of units and symbols
  (5) sections on areas of interest to the householder:
      (a) shopping in metric
      (b) conversion in the kitchen, classroom, for the handyman, on the road, and in sports
  (6) conversion scales and price comparison scales
  (7) table of "Metric Units for Everyday Use".

  Throughout the margins of the booklet are line drawings of people living in a metric world which is very similar to the imperial world they have been living in. This booklet evidently has been very well received by the general public and teachers alike.

Program Results

In each of the states analyzed we attempted to determine program effectiveness. Over and over again the answer was the same. No formal evaluation has been conducted. However, based upon the lack of complaints and the minimum number of requests for help, the generally

accepted conclusion on the part of our information sources was that metric training went very well.

Representative of the information from all states was the view of an individual from Tasmania who was responsible for much of the teacher training there. He bases his conclusion of program success on the fact that there have been no complaints from teachers about the inadequacy of their preparation for metric education. Our informant feels that when teachers are discontented, they make it known, and that there has been no "rumble in the ranks" over this subject. The extent of teachers' knowledge of SI, the degree of knowledge they are imparting to students, and the impact of metric conversion on the teaching of concepts of measurement and arithmetic, however, remain unknown in Tasmania, as they do in the rest of Australia.

About the only additional information we were able to glean concerning program success was that the MCB publications seemed to work very well in educating teachers and that the teacher education kit developed in Queensland proved useful in dispelling any problem with metric education.

Teacher Training Problems

As already noted, there appears to have been little in the way of repeated major problems associated with teacher training in metrics. It should be emphasized of course that no complete or formal evaluation has taken place. Rather, that was the view of our contacts in the various state education departments. This seemed particularly true in the case of math and science, which were viewed as less troublesome than vocational or technical education. Technical education involves the use of real hardware which is made in certain sizes and takes time and money to change. It also involves close cooperation with the industries. It is on the one hand quite diverse and, within each area, quite specialized so that a lot of attention has to go into many areas.

The Technical Branch in one state, for example, has a program for the conversion of equipment. For such things as rules and micrometers

used in everyday work this involves bulk purchases which schools can take advantage of. For equipment which can be converted, such as lathes, there are programs for technicians to move about the state converting a school at a time. There is no formal training or advice about this newly converted equipment, but it is believed that the technicians who do the conversion talk about the equipment to the teachers using it. Other equipment which cannot be modified will be replaced with metric sizes as it becomes obsolescent. For some things, there are no programs for conversion as yet because there are no metric standards available.

One of the major areas of concern for the Techncial Branch has been the conversion of textbooks. The market for many specialized technical textbooks is very small, and generally a commercial publisher would not be interested. This used to mean that every teacher developed his own set of notes to work from, and sometimes didn't change them during his teaching career. Recently, there has been an increasing tendency for the Education Department to publish its own books in technical subject areas. These books are generally produced in a quantity sufficient for three years and as they need to be reprinted are revised. Metric conversion has been taken as an opportunity to speed the development of such texts and the revision of others. These revisions are all closely monitored by the Special Projects Officer for metric conversion, and by the officials of the MCB before they are printed. No special inservice training is associated with the release of a revised or new text in a technical subject.

One of the problems faced especially by instructors in the technical area as they learned the SI units was the absence of an intuitive "feel" for the correct dimensions. This lack of a "sixth sense" for metric units was obvious in both student behavior as well as on the part of staff. Vocational education instructors reported that although they could instantly detect errors in the selection of materials and in machine settings under the imperial system, this ready visualization had to be painfully relearned for the metric system.

Of the problems cutting across all subject areas, one state reported the problems of money and communication. Of the two, the

major problem was money; specifically, not enough of it to do things as quickly and as completely as possible. In this case, it was not only the State Education Department that was lacking in money but also the Metric Conversion Board. As we have seen, the publications of the MCB played a large part in the inservice training of teachers. More of this material would have been used more extensively--distributed to more teachers and in many cases even to students--had it been available. But the MCB was in most cases not prepared to provide thousands of additional copies that might have been needed. The Education Department of Victoria, for example, received only two copies of the monthly MCB Newsletter which had, in effect, to be shared by all administrators and teachers in the state.

Another major problem, also endemic to educational systems, is one of communication. It is sometimes hard for communication to filter down from the top. There are too many places where a gap can occur--between the administrators and the principals, between the principals and the department heads, between the department heads and the working teachers. One of our interviewees who spends a good deal of time visiting schools and talking about metric conversion problems had more than once told people that answers to their problems had been sent out already, only to find that the circulars, or notes, or bulletins, had been filed by the clerical staff of the school, never to reach the teachers.

This same state also reported a schedule slippage problem. Textbooks in SI terms were promised almost without exception for the 1974 school year. This promise was not met. Even text revisions in some subjects were not ready for the 1974 school year.

Conversion often presents some new demands on teacher training. In the adult education area, courses were offered both for the general public in Australia, as well as for special groups such as small businessmen, real estate salesmen, timberworkers, etc. In some areas, it has been difficult to find teachers who are willing to teach the metric system to adults. In the early stages there was also some problem of lack of public interest. In 1972, for example, several courses

for the general public that were planned in Tasmania had to be cancelled because of poor attendance.

As mentioned before, objective and formal evaluation of Australian teacher training efforts have been nonexistent. Some evaluation along these lines would be part of what one respondent would change, if he could organize the program again. As we have mentioned, the initial seminars with primary teachers and the work within the schools by the coordinators were intended to provide stimulus to the individual teachers to do on their own the work necessary for them to master SI sufficiently to teach it. Our interviewee would have liked to schedule a follow-up seminar sometime later than the one given to provide more "hard" information where necessary and to test in some way the extent to which teachers had learned SI.

Other than these, the problems have been minor. There have been the occasional human difficulties. Most teachers required reassurance that metrication would not be too difficult or threatening to them personally. There are grumbles from some teachers who say "I've only got three years until I retire--why couldn't they just wait until I don't have to worry about it?". Some of these human worries have been caused by the communication problems, with teachers sometimes feeling that they don't know what the administrators will want them to do.

In summary, the problems of teacher training that have been identified appeared rather minor and not particularly unique to metrication. Instead, they were characterized as illustrative of the more general need of schools having to cope with a changing world.

Summary of Australian Teacher Training Efforts

Australia's inservice teacher training for metric education has been characterized by both intense activity and relative apathy, and the range of possibilities in between. Several clearly important aspects have emerged.

Training Strategies

Activity-learning workshops have been important. This approach has been utilized mostly on the primary level where many have felt that it was important for teachers to gain experience with metric units through activity-learning similar to that which would be used for children. The lectures, quizzes and displays associated with these workshops have usually been seen as reinforcing the knowledge learned through activity. Workshops such as these have been reported as very successful, especially those conducted by the inspectors and advisory teachers who served as traveling change agents throughout Queensland.

A type of seminar has also been important in Australia. This is the seminar for key people who will then become responsible for aiding others to cope with metric conversion. We have seen two kinds of this type of seminar. In the first, an attempt is made to convey a great deal of information to those who must first learn about SI and will be expected then to pass on the information. In the second, people are chosen as key people because they already possess the knowledge and the focus of the seminar is on strategies for disseminating that knowledge. The second kind tends to be shorter and more informal than the first kind.

Curriculum and Materials

Curriculum revision and the distribution of material about the revised curriculum has also had an important place in the Australian inservice training program. Such training is of a somewhat informal nature in that the teacher trains himself using material provided. Much of the training in Australia, as we have seen, has been of this informal nature. Curriculum revisions have ranged from very straightforward to very complex. Where they have been complex this is mostly accounted for by the fact that metrication has been included in an already scheduled revision. Early in the process of metrication, in some states, teachers had to modify their own curricula on the basis of guidelines provided.

Material prepared for teachers has ranged in scope from almost non-existent to reasonably comprehensive. Nowhere does it seem to have overwhelmed teachers. What has been available has usually focused on three sorts of things. One is the place of the metric units in the curriculum and their impact on other subjects. The second has been the provision of exercises and activities to be assigned to students. The third is the presentation of information about SI. This third element has sometimes seemed rather perfunctory compared to the importance of the first two. Much of such material has been adapted from other sources.

Audiovisual material played little part. Those who planned workshops and seminars usually considered films, but could not find ones they considered adequate. A common complaint was that available films tried to do too much too quickly and overburdened the audience with too much material, thereby losing effectiveness.

Linkage to Adult Education

The metric inservice training of teachers can be considered a subdivision of inservice training in general and that, in turn, can be seen as a subdivision of adult education. Anything useful for the latter two is potentially useful for the teacher. Repeatedly in our investigations we encountered the opinion that the major material used by teachers to train themselves was that prepared for the general public or for special interest groups. This material, especially that prepared by the Metric Conversion Board, often worked so well that little need was seen for additional material aimed especially at teachers.

Lack of Evaluation

As far as we have been able to determine there has been no evaluation of any aspect of Australia's metrication. This makes it difficult to judge the effectiveness of any of the inservice training efforts. All of those interviewed felt that their programs, whether the most simple or the most elaborate, worked very well. Even when those responsible said that they would change things if they had to do it over

again, the changes are not fundamental. Given another chance, people would try to do essentially what they did the first time, only better.

Overall, Australian teachers were seen as intelligent, educated individuals who generally did not need intensive training to cope with metric education. However, no one has any clear evidence of what children are learning or how well teachers are actually teaching metric measurement.

IMPLICATIONS FOR U. S. TEACHER TRAINING

This report represents an attempt to review the teacher training experiences of two countries. However, the reader should be cautioned that in one of these countries, England, much inservice teacher training had passed across the limelight without detailed documentation. In both countries the budget constraints of the study restricted the size of the sample to key individuals in selected educational agencies. However, within these constraints, the following study conclusions and recommendations are presented as relevant to U. S. planning and adequately supported by evidence from the overseas experience.

- Inservice training should function as an integral part of a carefully designed, well-planned and coordinated metrication effort with strong national leadership and direct representation of all parties concerned.

  In the United States, with its extensive degree of decentralization in educational structure, the importance of overall national planning is of great significance. Without well-coordinated implementation, inservice teacher training could become a crazy patchwork of haphazardly arranged programs. A lack of coordination would lead not only to needless initial expense, because of duplication of effort, but also to excessive long-range expense due to the need for substantial retraining of individuals who had learned inconsistent "standards" and applications.

  An exemplary attempt at interstate coordination is represented by the Interstate Consortium on Metric Education (ICME), a consortium of 24 states, the District of Columbia, and three territories. This consortium was organized by the Mathematics Education Task Force of the California State Department of Education for the purpose of bringing together representatives of states having centralized textbook adoption policies in order to develop guidelines for educational materials and encourage

coordinated metrication policies in education (1974). Although the participants in the consortium were primarily from mathematics and science backgrounds, their recommendations stress the interdisciplinary aspects of metrication.

- Primary emphasis should be placed first on overall systems planning of teacher training programs rather than rushing to conduct individual workshops.

One of the common responses to the news that metrication is coming is the rush to establish teacher training workshops. Often this is done without sufficient information on competency requirements and without crucial schedule information in either the field of education or in other sectors of society. The cost-effectiveness of such training can well be questioned, particularly if teachers return to their schools without a well-defined program to reinforce training experiences in their own classrooms and the support of follow-up training. Unfortunately, this epidemic of workshops appears to have begun in the U. S. due, at least in some measure, to the lack of national legislation.

The overseas experience suggests that, while the planning for inservice training should take place as early as possible, the actual conducting of the skill development workshops should be accomplished as close as possible to the time when the new knowledge will be applied on the job.

- The parallel needs of teacher education and adult education should be kept clearly in mind in designing metric training materials.

Many of the concerns and information needs of teachers are identical to those of the general public and to those in other occupational areas. It is sheer waste to develop teacher training materials oblivious to materials being developed for other

adult groups. Conversely, all metric educational materials should be considered as potential teacher training material. Everywhere we interviewed in Australia, for example, it was obvious that training material originally directed toward groups other than teachers was a valuable ingredient in teacher inservice training and a major factor in holding down metric education expenses. Decisions concerning appropriateness, approach, style and content of all adult educational materials should be made with the recognition that such materials might well be employed in teacher inservice programs.

- In planning metric education programs, ample funds should be provided for disseminating effective programs and materials.

One of the areas that can easily be overlooked in metric education budgets is the need for wide dissemination of effective training programs and materials. The full benefits of expensive developmental programs can be frustrated by false economy in the dissemination area. To rely on school districts or individual schools to duplicate the materials and distribute them to teachers increases the overall publication costs and shifts the burden to the user agencies. Even worse, it prevents worthwhile materials from being put into the hands of people who need them the most.

- Direct communication links with teachers should be established early in the metrication program.

Closely related to the need to provide adequate budgets for materials and information dissemination activities is the need to ensure that teachers are kept informed of metrication news at the federal, state and local levels. Lack of information can be very disruptive and disturbing to teachers especially in the early stages of metric planning when frightening, error-

ridden rumors abound. Judging from the overseas experience in metric education, as well as from experiences gained in similar situations in the U. S., it will be a serious mistake to assume that metric memoranda and newsletters distributed to state departments of education, school districts or even to individual schools will automatically and expeditiously be delivered to the teachers most concerned. Some method of communicating directly with teachers, such as a newsletter or a periodic memorandum, merits early consideration.

- The reduction of anxieties, particularly among older teachers, should be dealt with before actual training in SI.

Many teachers, particularly older ones, were fearful of the changeover process. Unnecessary fears often blocked effective teacher training. These inadequately trained teachers were then unable to teach effectively in the classroom. Anxiety about SI needs to be dealt with openly, and before efforts are made to train teachers in the actual use of the system. If dealt with promptly, and by demonstrations of the basic simplicity of direct measurement in the metric system, the anxieties can be reduced. The avoidance of an emphasis on conversion in all aspects of training was one of the strongest recommendations for reducing and preventing unnecessary fears during training. A pre-training awareness unit demonstrating metric simplicity and identifying each source of anxiety and how to cope with it should be incorporated into introductory training plans.

- Priorities in training should be given to teachers in all subject areas, not just math and science.

It is easy to fall into the trap that teacher training should be focused on math and science. Actually, overseas experience indicates that, while math and science teachers certainly require training in SI, teachers in other subject areas should not be

overlooked. Elementary teachers and vocational education and home economics teachers require extensive assistance both in training and materials.

- Careful attention should be given now and throughout teacher training to close adherence to agreed-upon SI symbols, definitions and spellings.

  Variations in spellings, definitions and symbols were often impediments in the early phases of metrication. Universal adherence to standards is essential. Educators would be well advised to keep handy an authoritative metric practice guide such as the U. S. Department of Commerce publication NBS 330 (1974) or the American Society for Testing and Materials publication E 380 72$^{\varepsilon}$ (1973).

- Training should be scheduled in short activity sessions, distributed over time and alternated with classroom tryouts of materials and strategies.

  Almost unanimous support was voiced by our overseas interviewees for scheduling a series of relatively brief training sessions which would allow teachers to practice newly acquired metric skills and materials, try them out with students, and then return for additional training. The follow-up sessions would emphasize evaluation, discussion and refinement of their approach. A two- or three-hour session each week for six to eight weeks was highly endorsed and considered completely adequate for training. One-time, crash courses received little support.

  Teachers overseas were universally adamant on the importance of active learning in training sessions. Small-group discussions of problems and work parties were repeatedly compared favorably as opposed to the lectures, films and other large-

group presentations. This was particularly true for those training programs emphasizing specific knowledge and techniques in using SI. The use of large-group media-based presentations may play a useful role in general orientation and awareness of the need for metrication.

- The uneven quality of initial metric materials presents a challenge to teachers to develop their own material and thereby learn SI in the process.

In the early stages of metric conversion, teaching staff, sometimes in almost a state of panic, grasp at the first seemingly relevant teaching aids to come along. Too often the early flood of materials contains many items of poor quality, from the viewpoint of construction, accuracy of symbols and metric units, poor calibration or a combination of these shortcomings. Unfortunately, technical assistance in identifying useful materials may not be available in the early phases of teacher training. However, overseas training programs have stressed teacher development of materials as an important training strategy. During the course of inservice training, the learning of SI can be deeply ingrained by designing and constructing simple teaching aids to SI specifications, with sizeable savings in expenditures for truly relevant, instructionally useful materials.

- To gain maximum proficiency in teaching the metric system of measurement, teacher inservice training should encompass the same exercises as those the students will perform.

Overseas experience repeatedly emphasized the great importance of activity-learning workshops. This approach was utilized extensively at the primary level where many educators felt that it was crucial for teachers to gain experience with metric units through the same learning activities used by children.

- The English Teachers' Centres and the Australian traveling advisors should be given serious consideration as useful models to promote innovation.

The Teachers' Centres with their emphasi upon teacher direction and teacher involvement in professional upgrading were a major positive influence on metric education in England. They provided facilities and support for motivated teachers to learn SI as well as to develop and try out materials. Such Centres, largely under teacher control, contrast sharply with typical U. S. inservice training. The traveling change agent model, similar to the agricultural extension agent, was utilized in parts of Australia. School inspectors and advisory teachers traveled throughout selected regions assisting local education agencies in planning and conducting teacher training. With these two approaches, the U. S. is presented with a potentially powerful set of tools to shape useful social change.

- Early provisions should be made for an evaluative feedback loop covering metric materials, planning, teacher training, and instruction.

One of the grim conclusions of our overseas studies was the almost complete absence of evaluation components in any aspect of metric education. Teachers were most vocal about the early need for evaluative guides to materials. We found the lack of any but the most subjective evaluation of teacher training, and the complete lack of instructional evaluation especially disheartening.

To complete our conversion to metric education will take some time. Well-designed evaluative research now could help later training programs. It is unfortunate that we cannot capitalize on existing evaluations of training models and materials conducted by the other countries that have gone metric. None exists. Australia and Great Britain have missed their chance to conduct

such studies. It is unlikely that Brunei, the Yemen Arab Republic and the People's Democratic Republic of Yemen (the other countries not committed to going metric) will have the resources or the inclination to undertake major evaluations when they eventually go metric.

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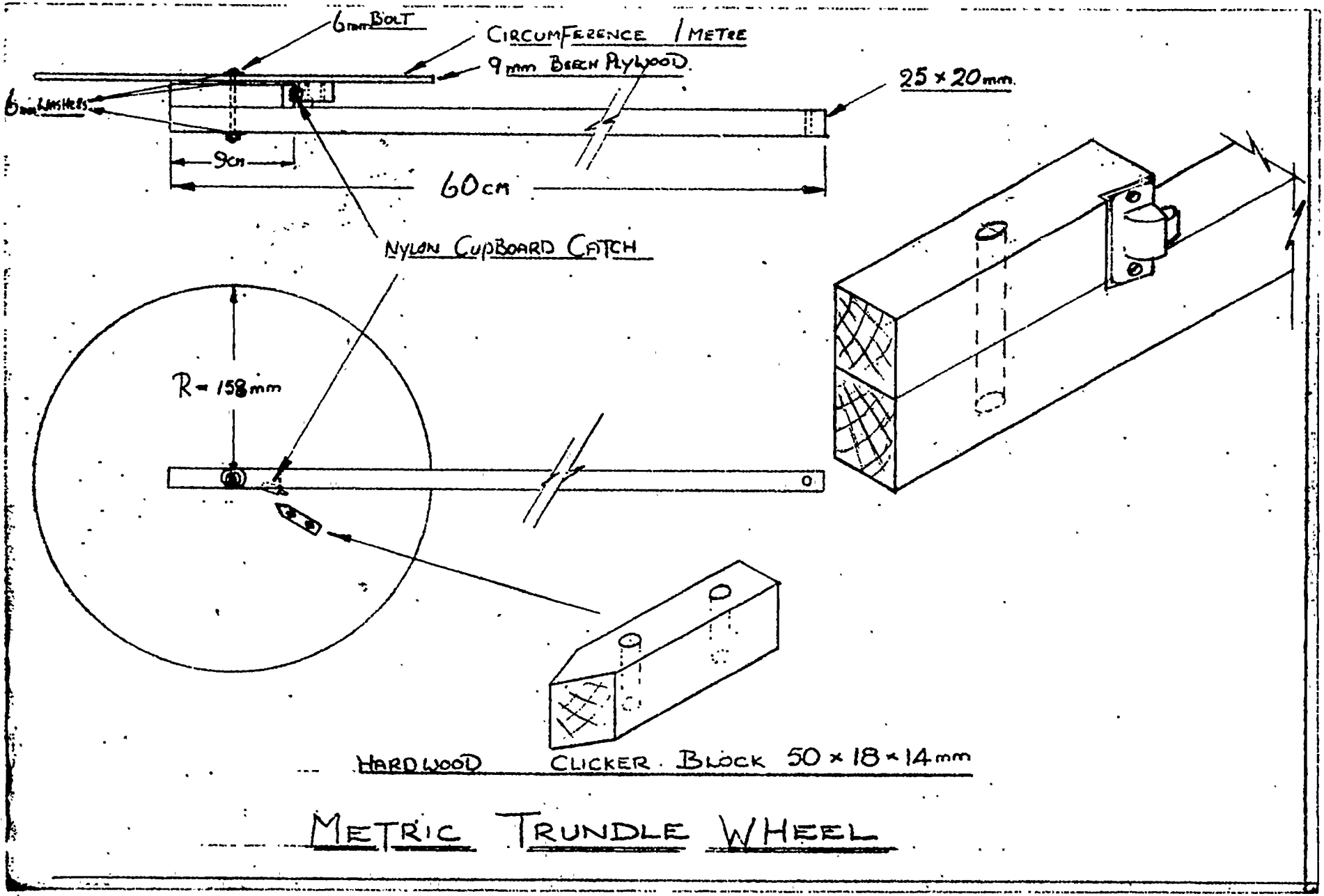
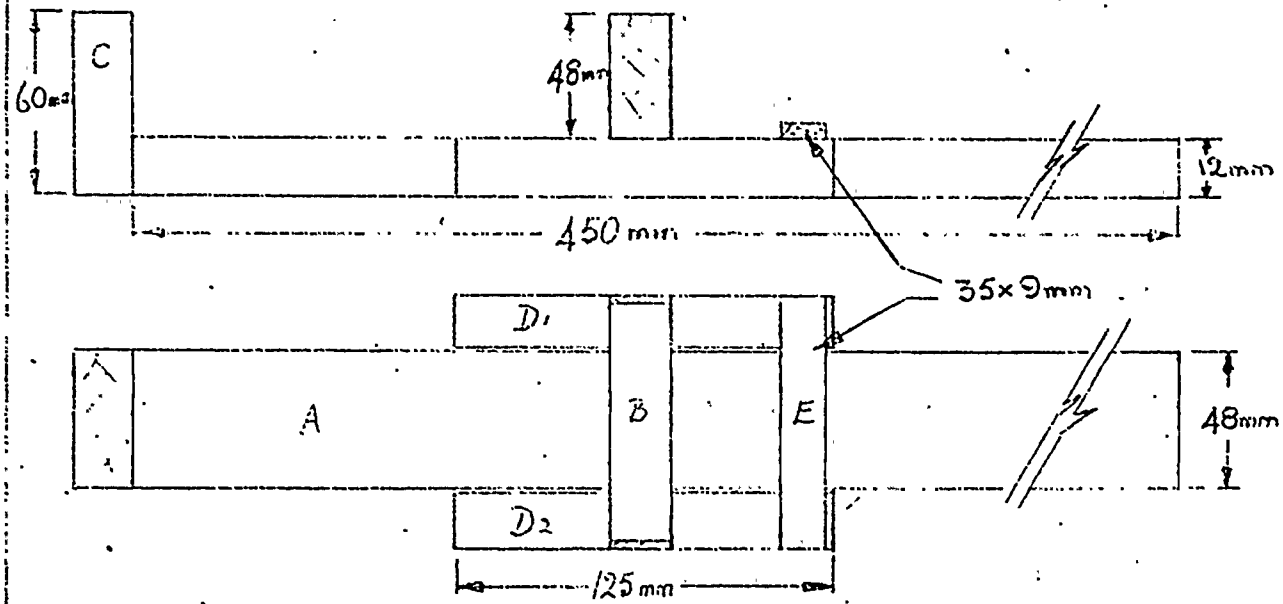
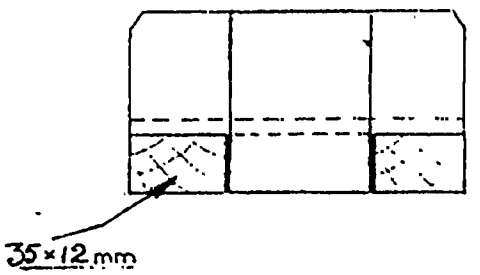
APPENDIX A

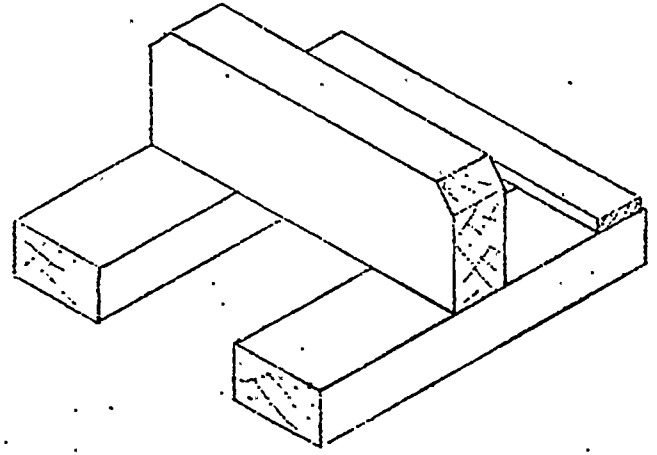
Working Plans for Teaching Aids in the T. F. Davies Teachers' Centre Metrication Kit

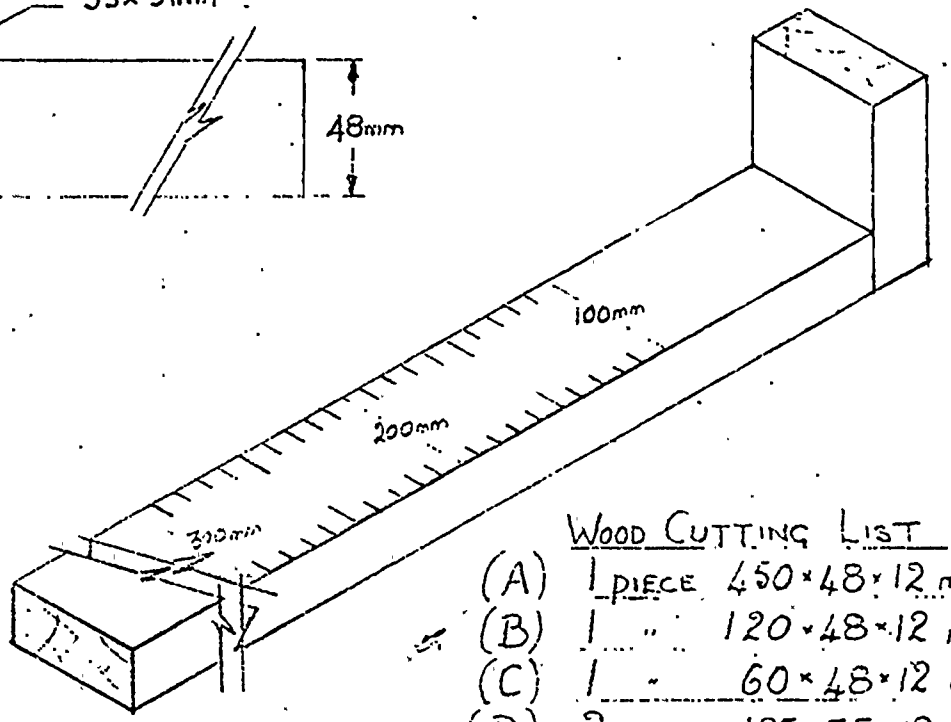


METRIC TRUNDLE WHEEL







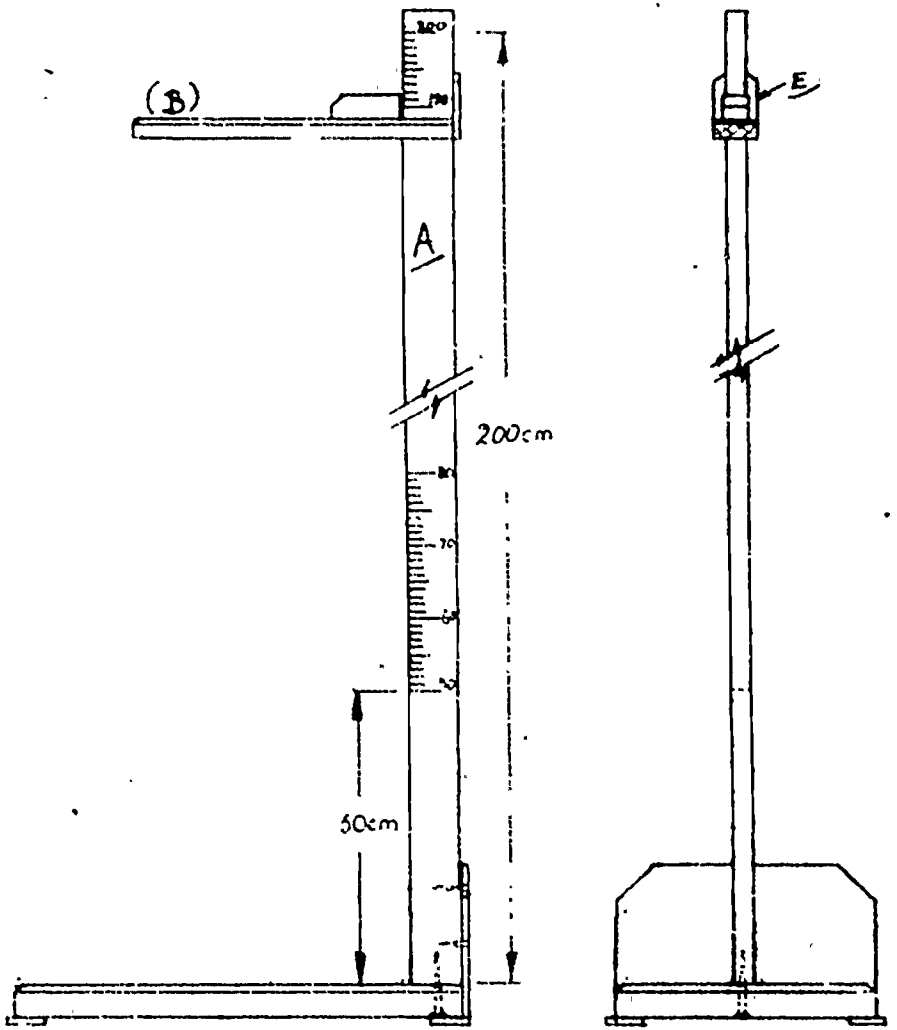


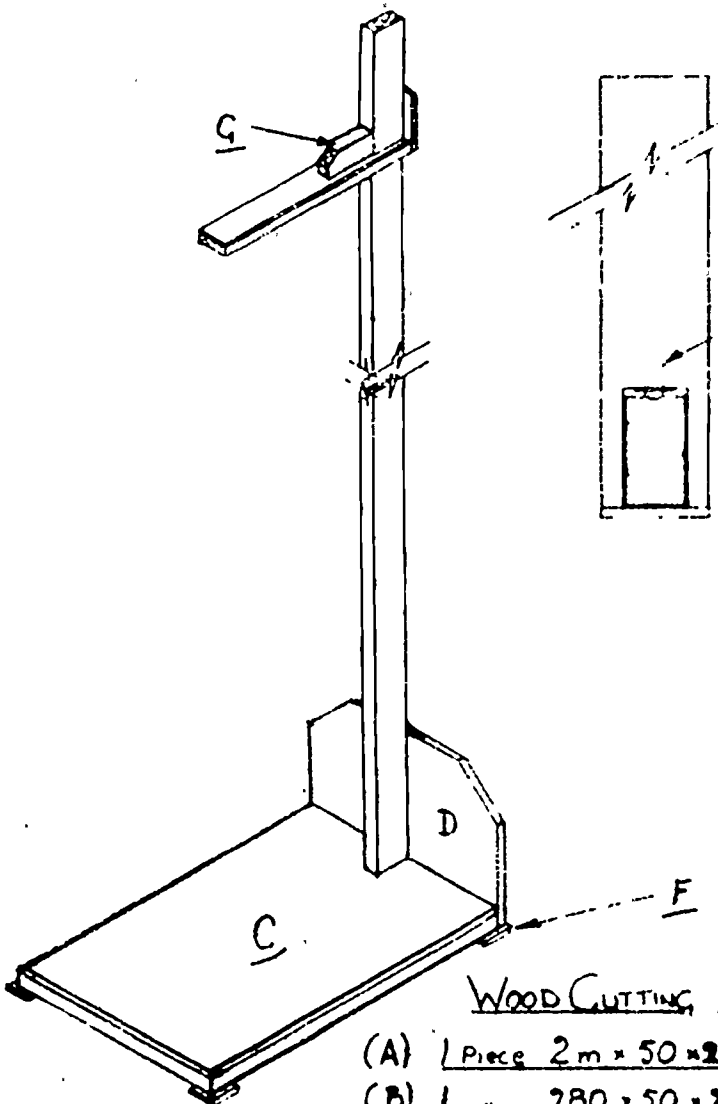
Wood Cutting List

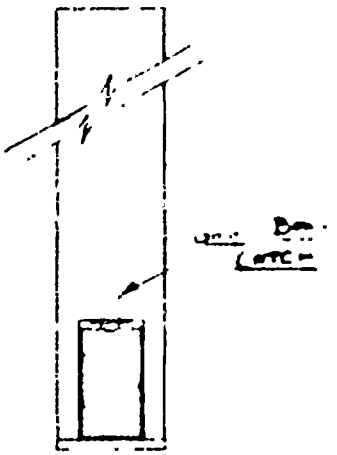
(A)	1 piece	450×48×12 mm
(B)	1 "	120×48×12 mm
(C)	1 "	60×48×12 mm
(D)	2 pieces	125×35×12 mm
(E)	1 "	120×35×9 mm

Metric Foot Measure

Not Drawn To Scale





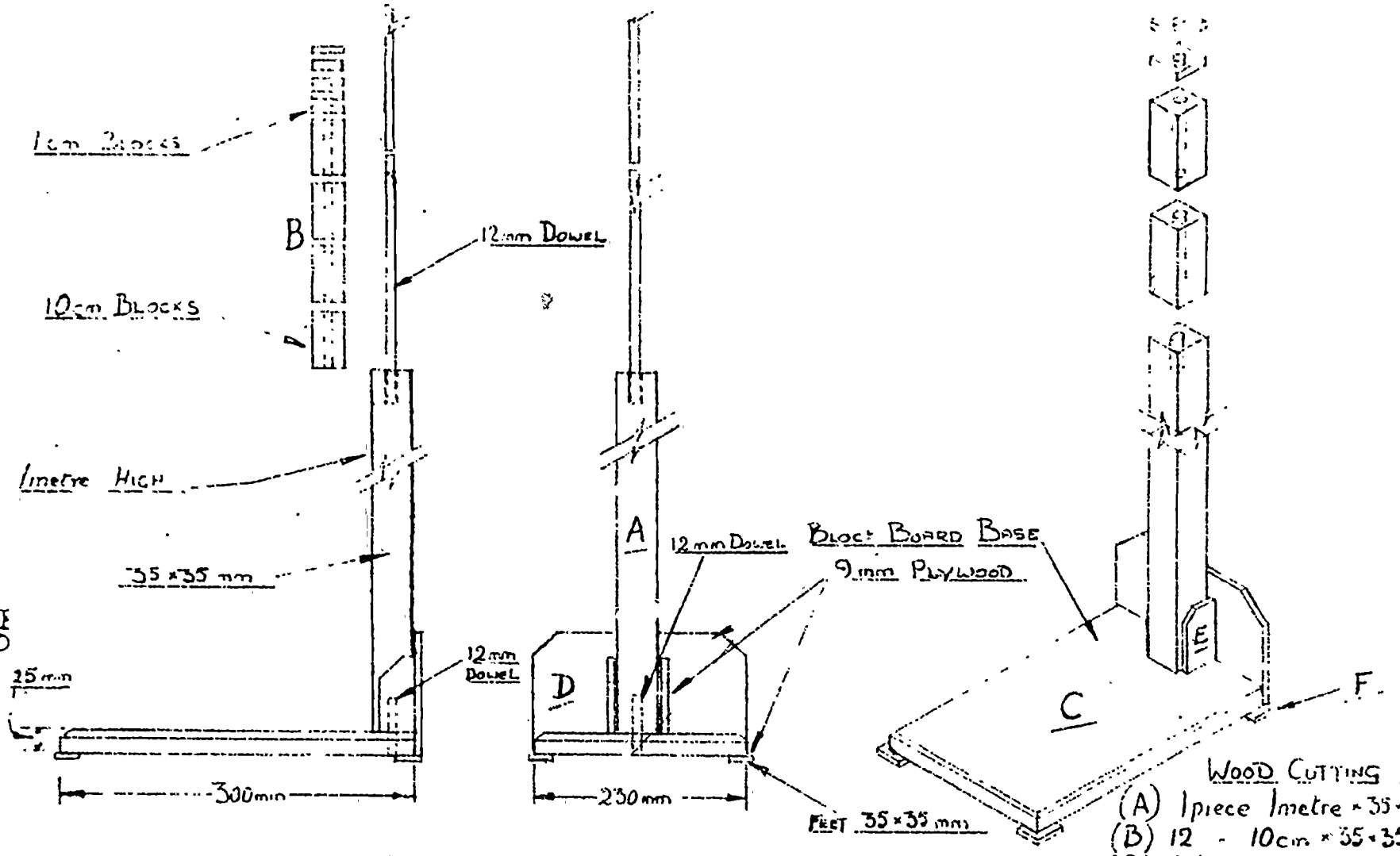


Wood Cutting List

(A)	1 Piece	2m × 50 × 25 mm
(B)	1 "	280 × 50 × 25 mm
(C)	Base	300 × 230 × 25 mm
(D)	Back	230 × 125 × 25 mm Ply
(E)	1 Piece	80 × 50 × 9 mm Ply
(F)	4 "	35 × 35 × 9 mm Ply
(G)	1 "	50 × 35 × 25 mm

Free Standing Height Measure With Slide

Drawing Not To Scale



78

Wood Cutting List

(A) 1 piece 1metre × 35 × 35 mm
(B) 12 - 10cm × 35 × 35 mm
(C) 1 base 300 × 230 × 25 mm
(D) 1 piece 230 × 125 × 9 mm Ply
(E) 2 " 80 × 30 × 9 mm Ply
(F) 4 " 35 × 35 × 9 mm Ply
(G) 3 " Dowel 300 × 12 mm

DRAWING NOT TO SCALE

Built up Free Standing Height Measure

APPENDIX B

Examples of Metric "Activity Cards"
Designed by Tasmanian Teachers

LENGTH

Needed: Trundle wheel or measuring tape. Stop watch.

Work with a partner.

Measure out the following distances:

25 m
50 m
100 m

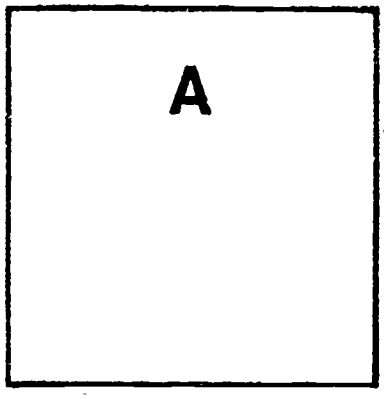
Record the time taken to run each distance.

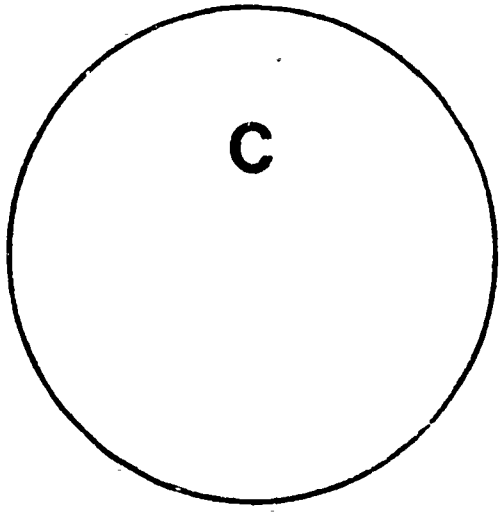
Distance	Time
25 m	
50 m	
100 m	

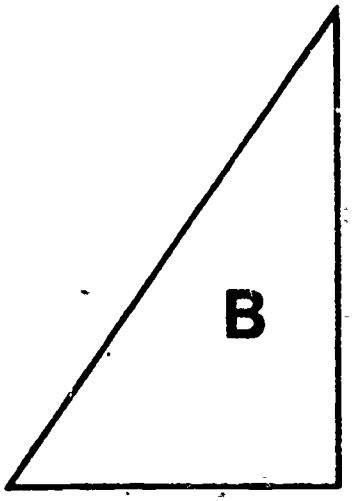
AREA

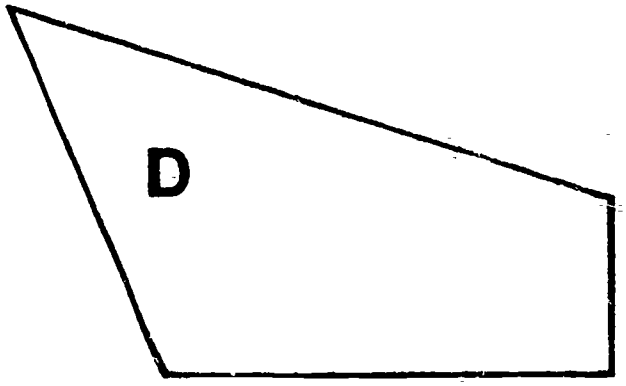
Needed: Transparent grid marked in cm^2.

Fit the grid over each of the following shapes to measure the area of each in cm^2. Count as whole units any fractions greater than 0.5 cm^2. Forget about any less than 0.5 cm^2.









MASS

Needed : Bathroom scales and tape measure.

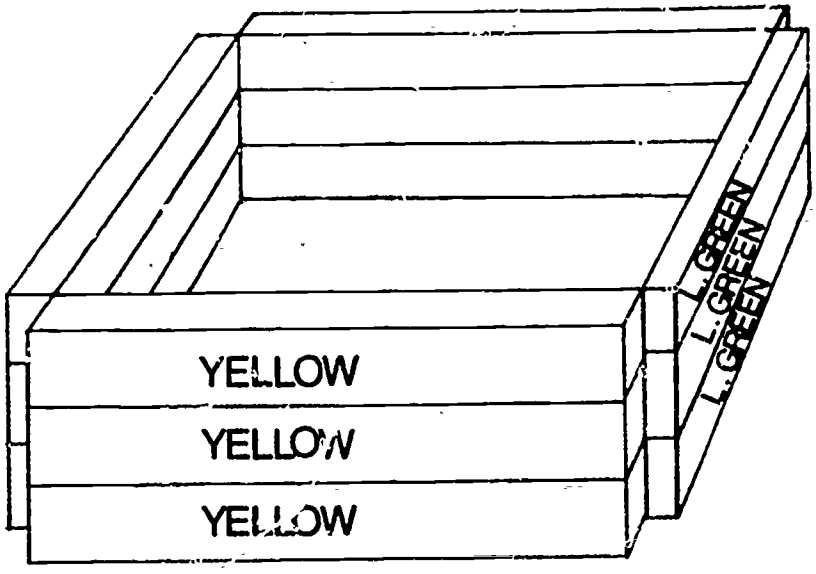
1. Select the smallest and tallest pupil in your class and three others. Find the mass of each pupil.
2. Has the smallest child the least mass? Has the tallest the greatest?
3. Arrange the masses in order in a table like this –

	NAMES	MASSES
1.		
2.		
3.		

4. Find the difference in mass between the first child and the last child.
5. Find the total mass of the five children.

VOLUME

1. Cut off the lid of a chalk box so that it is 2 cm deep.
2. Measure the length and breadth of the box in cm.
3. How many white cuisenaire rods would be needed to fill the lid?
4. Can you see a connection between this answer and the measurements above?
5. Using cuisenaire rods make a container as follows:



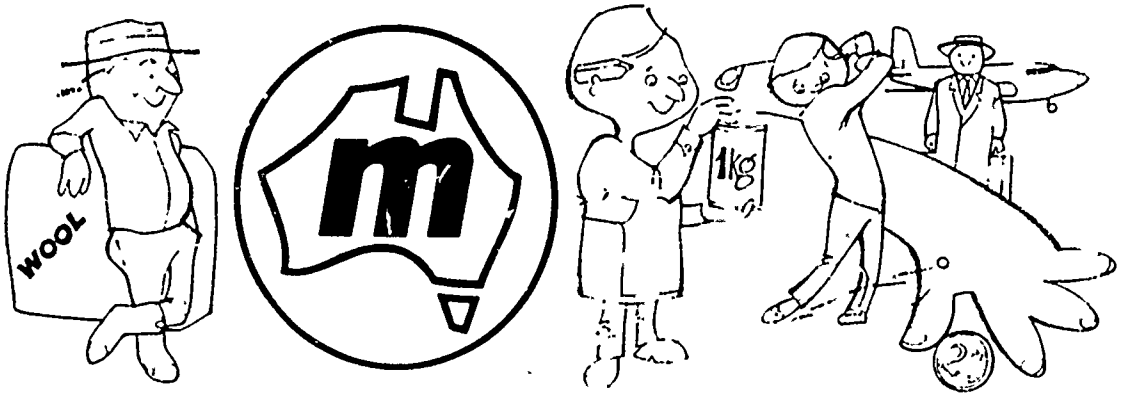
See if you can find a quick way of working out the number of white rods that it will contain.

Check by filling it up with white rods.

Can you see a way of using a rod of a different colour to make your checking quicker?

APPENDIX C

Australian Metric Conversion Board Posters
Included in the MCB Metrikit



HOW HEAVY?

GRAM (g), KILOGRAM (kg), TONNE (t)

METRIC PREFIXES **kilo** (k)—means thousand
milli (m)—means thousandth

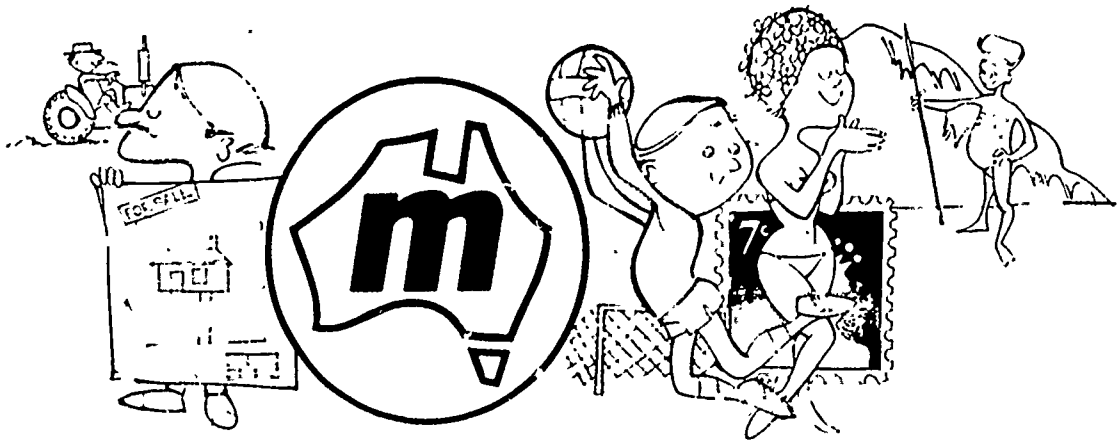
1000 g = 1 kg, 1000 kg = 1 t

1 g	About the mass of three aspirin tablets
5 g	About the mass of a two cent piece
50 g	About the mass of a golf ball
500 g	A little more than one pound
1 kg	A little more than two pounds
20 kg	Luggage allowance for economy class air travel
70 kg	About 11 stone
1 t	A little less than one ton

CONVERSION TABLE: 1 lb = 0·453 592 37 kg (exact)

Approximate values: 1 oz = 28·35 g; 1 lb = 453·6 g; 1 stone = 6·350 kg; 1 cwt = 50·80 kg; 1 ton = 1·016 t

PRODUCED BY THE METRIC CONVERSION BOARD



HOW BIG?

SQUARE MILLIMETRE (mm^2), SQUARE CENTIMETRE (cm^2), SQUARE METRE (m^2), HECTARE (ha), SQUARE KILOMETRE (km^2).

METRIC PREFIXES

kilo (k)—means thousand
deci (d)—means tenth
centi (c)—means hundredth
milli (m)—means thousandth

$100\ mm^2 = 1\ cm^2$; $10\ 000\ cm^2 = 1\ m^2$; $10\ 000\ m^2 = 1$ ha; 100 ha = $1\ km^2$

2 mm^2	About the area of the top of a pin head
5 cm^2	The area of the seven cent Queen's head stamp
1 m^2	About the area of a shower recess floor
100 m^2	Is about the area of an "11 square" (1100 ft^2) house
1000 m^2	Is the area of an olympic swimming pool (50 m x 20 m) Is the area of a normal quarter acre building block
1 ha	About the area of a soccer field or of a square 100 m x 100 m
3·7 km^2	Is the area covered by Ayers Rock

CONVERSION TABLE: 1 yd^2 = 0·836 13 m^2 (legal conversion factor)

Approximate values: 1 in^2 = 645·2 mm^2 = 6·452 cm^2; 1 ft^2 = 929·0 cm^2 = 0·092 90 m^2;
1 yd^2 = 0·8361 m^2; 1 perch = 25·29 m^2; 1 rood = 1012 m^2;
1 acre = 0·4047 ha; 1 square mile = 2·590 km^2

HOW FULL?

MILLILITRE (ml), LITRE (l), KILOLITRE (kl),
CUBIC CENTIMETRE (cm^3), CUBIC DECIMETRE (dm^3), CUBIC METRE (m^3).

METRIC PREFIXES

kilo (k)—means thousand	centi (c)—means hundredth
deci (d)—means tenth	milli (m)—means thousandth

1 cubic metre (m^3) = 1000 litres (l) = 1 kilolitre (kl);
1 litre (l) = 1000 millilitres (ml); 1 cubic centimetre (cm^3) = 1 millilitre (ml)

1 ml	About one eye dropper full
5 ml	One standard teaspoonful
200 ml	About 7 fluid ounces
600 ml	A little more than a pint
1 litre	A familiar wine quantity
200 l	The capacity of a 44-gallon drum
1 m^3	About 1⅓ cubic yards

CONVERSION TABLE: 1 yd^3 = 0·764 555 m^3 (legal conversion factor)
1 gal = 0·004 546 09 m^3 (exact)

Approximate values: 1 gal = 4·546 l; 1 fl oz = 28·41 ml; 1 pt = 568 3 ml
1 in^3 = 16·39 cm^3; 1 ft^3 = 0·028 32 m^3; 1 yd^3 = 0·7646 m^3

NOTE-IMPERIAL MEASURE COMPARISONS